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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

IS MUTATION A FACTOR IN THE EVOLUTION OF THE HIGHER VERTEBRATES?[1]

THE stir created among botanists and horticulturists by the recent work of de Vries, particularly by his Berkeley lectures (1904) on 'The Origin of Species and Varieties by Mutation,' has led certain zoologists to believe that species of animals as well as plants may arise by the sudden assumption of new characters. Thus Davenport, in a recent review, expresses the conviction that 'as good an argument might be made from the zoological side as de Vries has made from the botanical.' The promulgation of these views by so eminent a student of evolution as Davenport, in connection with the circumstance that more or less similar views are held by others, has led me to reexamine certain groups of birds and mammals, of which I had previously made systematic studies, for the purpose of discovering evidence, if such exists, of the formation of species by mutation.[2]

But first let us be sure of de Vries's meaning. He states that individual plants of a certain species of evening primrose

[1] Address of the vice-president and chairman of Section F—zoology—at the New Orleans meeting of the American Association for the Advancement of Science.

[2] It is important that the terms used by de Vries should be understood. What we systematists have been in the habit of calling spontaneous variations or '*sports*' he calls '*mutations*'; what we call '*individual variations*' he calls '*fluctuations*'; and what we call the '*characters*' of species he calls '*qualities*.'

which he kept under observation for a period of years, suddenly developed abnormal new characters or 'qualities' that were inherited and gave rise to permanent new species, which continued to exist side by side with the parent species. This process he calls 'the origin of species by mutation.' While admitting the extreme rarity of occurrences of this kind, he appears to have been carried away with enthusiasm over his discovery and jumps to the conclusion that species in general originate by mutation—and in no other way!

After stating that species 'are not in the main distinguished from their allies by quantities nor by degrees; the very qualities may differ,' he goes on to say that *if* the differences in quality can not be explained 'by the slow and gradual accumulation of individual variation,' and *if* the sudden variations called sports or mutations, 'can be shown to occur in nature as well as they are known to occur in the cultivated condition, *then* in truth Darwinism can afford to lose the individual variations as a basis.' Continuing the argument, he declares: "Then there will be two vast dominions of variability, sharply limited and sharply contrasted with one another. One of them [that of individual variation] will be ruled by Quetelet's law of probability and by the unavoidable and continuous occurrence of reversions. It will reign supreme in the sciences of anthropology and sociology. Outside of these, the other [that of sports or mutations] will become a new domain of investigation, and will ask to be designated by a new name"—the origin of species by mutation. There would seem to be no doubt as to de Vries's meaning. The question is, are his assumptions justified by the facts in nature? It will be observed that he deems the perpetuation of individual variations jeopardized 'by the unavoidable and continuous occurrence of reversions.' Let me ask in all seriousness if sport variations are less likely to disappear by reversion than are individual variations?

Let us now examine the '*if and ands*' of de Vries's argument. The first of these is: *If* the differences in quality [characters] 'can not be explained by the slow and gradual accumulation of individual variations * * *.' May one venture to ask, Why can they not be so explained? Is it not true that up to the time of the announcement of his new theory a little more than a year ago it was the practically unanimous belief of zoologists and botanists the world over that the differences in quality that go to make species do originate in precisely this way? And has any reason been brought forward to justify—much less necessitate—a change in this belief? Are we, because of the discovery of a case in which a species appears to have arisen in a slightly different way—for after all the difference is only one of degree—to lose faith in the stability of knowledge and rush panic stricken into the sea of unbelief, unmindful of the cumulative observations and conclusions of zoologists and botanists?

De Vries's second and third *ifs* are: "*If* such strains [produced artificially among cultivated plants] can be proved to offer a better analogy to real systematic species, and *if* the sudden changes can be shown to occur in nature as well as they are known to occur in the cultivated condition, then in truth Darwinism can afford to lose the individual variations as a basis." The logic of this is hard to see, for is it conceivable that 'strains,' or varieties produced artificially among cultivated plants, 'can be proved to offer a better analogy to real systematic species' than species produced in the normal way by the perpetuation of individual variations? 'And if the sudden changes [sports or mutations] can be shown to occur in nature'—and I admit

that they can—how does it follow that 'then in truth Darwinism can afford to lose the individual variations as a basis.' Is not this a case of enthusiasm run wild? Is it not like arguing that if it can be proved that a man ate meat for breakfast, then of course he could not have eaten bread! To my mind the striking fallacy of de Vries's argument is his assumption that because it can be shown that sports occur in nature, and that in rare cases species arise therefrom, then the theory that species are produced by the progressive development of slight individual variations must be abandoned. Why can not species originate in both ways? The occurrence of sports among animals and plants being admitted, the question arises as to what becomes of them. According to Darwin, Weismann, Dall, Jordan and a host of others they are lost by the swamping effects of interbreeding. That this is the usual result in both plants and animals I think every one will admit, for even de Vries frankly states that their perpetuation in giving rise to new species is so exceedingly rare that he is able to cite only a single authenticated case. I do not assume to be a botanist; nevertheless, for more than a quarter of a century I have been an earnest field student of plants in their relations to geographic environment. These studies have convinced me that with plants, as with animals, the usual way in which new forms (subspecies and species) are produced is by the gradual progressive development of minute variations.

But we are not now concerned with plants. The question before us is, 'Do species among the higher vertebrates originate by the sudden acquirement of new characters?' In seeking an answer I have passed in review more than a thousand species and subspecies of North American mammals and birds without finding a single one which appears to have originated in this way. Among the higher vertebrates, therefore, the conclusion seems justified that if species ever originate from sports, such mode of origin must be exceedingly rare. My own conviction is that the origin of species by mutation among both animals and plants is so uncommon that as a factor in evolution it may be regarded as trivial.

If species do not ordinarily originate in this way, it is fair to ask, 'How do they originate?' My answer is, 'By the slow but progressive acquirement of characters that have their beginning in minute variations.'

It is hardly necessary in the present connection to review the theories concerning the *inception* of variation, for whether or not we believe in the potency of dynamic influences, we all admit that individual organisms vary, and most of us are agreed that in the struggle for existence the beneficial variations are likely to be preserved, the harmful ones eliminated, by the action of natural selection. Some of us go further and believe that the universal and irrepressible tendency of organisms to vary results in the perpetuation, not only of distinctly useful departures, but sometimes also of those which, though not harmful, seem to be of not the slightest service to either the individual or the species. These, according to Dr. David Starr Jordan, owe their inception to geographic isolation. Dr. Jordan states: "The adaptive characters a species may present are due to natural selection or are developed in connection with the demands of competition. The characters, non-adaptive, which chiefly distinguish species, do not result from natural selection, but from some form of geographical isolation and the segregation of individuals resulting from it. * * * Adaptation is the work of natural selection; the division of forms into species is the result of existence under new and diverse conditions." Jordan's view is that 'the char-

acters by which one species is actually known from the next are rarely traits of utility.'[3]

This was Darwin's view also, for he says: "It is a strange result which we thus arrive at, namely, that characters of slight vital importance to the species are the most important to the systematist." T. H. Morgan goes even further, expressing his entire disbelief in the production of species through natural selection. Had he been familiar with the characters that distinguish many of our species of mammals, birds and reptiles he could hardly have held this view, for while in some groups the characters naturalists make use of in defining species are mainly of the indifferent kind, in others they are largely of the adaptive and useful kind. Thus among mammals, birds and reptiles dozens of species and subspecies are distinguished from one another by adaptive characters alone. At the same time it should be understood that, as a rule, species are based not on one but several characters, some of which may be adaptive, others non-adaptive.

PRESSURE OF THE ENVIRONMENT.

Darwin's definition of natural selection or the survival of the fittest is: "The preservation of favorable individual differences and variations and the destruction of those that are injurious."

Whether a particular variation is beneficial or injurious depends of course on the environment. It follows that variations in order to be beneficial must be in harmony with, or meet demands of, the environment. Whether such adaptations should be attributed wholly to the slow action of natural selection, or whether one may be allowed to cherish the belief that the environment not only invites but compels variation, involves a distinction as important as it is difficult of demonstration. Is there not a hidden force which independent of, or superadded to, the general tendency of organisms to vary acts as an incentive in initiating useful variations? Have we not evidence of this in the increased length of toes and feet in species inhabiting soft or marshy ground; increased thickness of bill in birds that habitually crack seeds or nuts; increase in the length of the canine teeth in mammals that catch and hold struggling prey; increase in the size of the carnassial teeth in mammals that crunch bones of other animals; special modifications of the feet to fit them for special purposes, as for wading, swimming or grasping; and also such variations as appear to result from prolonged and oft-repeated effort, as increased length of leg in species whose welfare depends on fleetness of foot, and greater development of the external ear, or greater complexity of the internal auditory apparatus which seem to be a consequence of long continued strain in listening for the approach of enemies or of prey? This subtle influence I like to call *the pressure of the environment.*

Dall was once bold enough to assert: "The environment stands in relation to the individual as the hammer and anvil to the blacksmith's hot iron. The organism suffers during its entire existence a continuous series of mechanical impacts, none the less real because invisible."[4] These are weighty words, well worth remembering.

While a number of our ablest naturalists hold this view, the current feeling among morphologists and physiologists is undoubtedly against it. Thus Thomas Hunt Morgan in his book on 'Evolution and Adaptation' (1903), says: "We can profitably reject, as I believe, much of the

[3] Science, N. S., Vol. XXII., p. 558, Nov. 3, 1905.

[4] 'Dynamic Influences in Evolution,' W. H. Dall, *Proc. Biol. Soc. Wash.*, VI., 2, 1890.

theory of natural selection, and more especially the idea that adaptations have arisen because of their usefulness.''

Is not the fact that such diverse opinions are held by thoughtful men of science in itself an illustration of the pressure of environment? For is it not obvious—since those who spend their lives studying species in nature hold one view, while those who spend their lives peering into microscopes and inventing theories hold another view—is it not obvious that such antagonistic views are the outgrowth of different environments?

To those who admit the existence of dynamic influences it is conceivable that the inception of the resulting variations, as long ago pointed out by J. A. Allen, is not confined to a single individual, to be lost or saved by natural selection, but being the response of organisms to forces applied alike to all members of a species in a given area, takes place simultaneously in a large number of individuals and is thus established more quickly and with much greater certainty.

VARIATIONS.

It is convenient for the systematist to consider variations under four heads: (1) Fortuitous variations; (2) dynamic variations; (3) sexual variations; and (4) seasonal variations.

1. *Fortuitous variations* are such as arise without apparent cause—for it is in the nature of organisms to vary. They originate in a single individual, and occur everywhere, in all species of animals and plants. They may be beneficial, neutral or injurious. The beneficial are likely to be preserved by natural selection and increased so long as the increase is beneficial to the possessor; the neutral may either disappear or persist; the injurious are promptly eliminated. According to degree of development at the time of their first appearance they may be designated *ordinary individual variations,* or *sport variations.* This is an old story.

2. *Dynamic variations* are such as arise, apparently, in response to pressure of the environment. They are necessarily beneficial, arise simultaneously in a number of individuals, and are cumulative so long as the increased development is helpful—that is until a condition of equilibrium is established between the organism and the environment. They may be *functional* or *geographic.* Those that are functional may be *local* or *general;* those that are geographic may be *local* or *progressive.* Variations resulting from change of food habits, or from the necessity of coping with a new enemy, or from the too rapid spread of a species from one area to another, may progress to full maturity in a given locality; but in the case of ordinary geographic variations the change progresses laterally from one district to another. Thus in species that undergo geographic color variations, the change as a rule takes place so gradually that specimens from adjacent localities may be hard to distinguish, while those from the two borders of the belt of intergradation may be markedly unlike. In this case the intergrades, as well as the extremes, are in complete accord with the surroundings, the members of the species at each step along the geographic line of intergradation having attained a state of equilibrium with reference to the environment at that point.

Usually the movements of animals and plants in acquiring new territory are slow, allowing time for the necessary adjustments to take place along the line of advance, so that no great change at any one locality is required. But it is conceivable that in certain cases the advance may be too rapid for this, bringing a species into an area to which it is not yet adapted, in which case the struggle for existence would be unusually severe and the development

of adaptive characters would proceed with corresponding rapidity.

Illustrations of functional and geographic variation in the same animal are afforded by the kangaroo rats (genus *Dipodomys*)—a group of American mammals highly specialized for life on arid deserts. These animals have numerous enemies and a multitude of competitors, which means that the struggle for existence is always severe. They are of small size and have big heads, big eyes, small fore legs and feet, exceedingly long hind legs and feet, and very long tails. The long hind legs and tail are special adaptations for saltatory progression—for leaping instead of running. Another general functional character is the extraordinary development of the internal organ of hearing, which forms more than half of the bulk of the skull, enabling the animal to detect the approach of its mortal enemy, the soft-footed desert fox.

In addition to functional variations of this kind, which are general or common to the group, there are others that are local in character and confined to particular species or subspecies. Of these may be mentioned the increase in size of the hind foot in forms inhabiting soft or yielding soils—an adaptation that is even more marked in certain other groups.

Turning now from functional to geographic variations, we find in certain species a marked decrease in size from the north southward. In *Dipodomys spectabilis*, which ranges from north-central New Mexico to southern Chihuahua—a distance of about 700 miles—the actual decrease in length is 52 millimeters (2 inches), or 14 per cent. of the total length. This is in accord with the general law of decrease in size from the north southward, announced by J. A. Allen many years ago.

The kangaroo rats furnish illustrations of still other matters of interest to the student of evolution. Passing the subject of color adaptations, of which much might be said, let us look for a moment at certain facts brought to light by a study of bodily proportions. Tabulation of the measurements of upwards of 500 adult specimens of the several species shows that individual variation is great, amounting in the hind foot to 15 per cent., in the total length to 20 per cent., in the length of tail to 24 per cent.—thus affording ample material for the evolution of new forms characterized by differences of proportion—but none such are developed. Indeed, the mean measurements throughout the genus are remarkably constant, the ratio of hind foot to total length varying only 2 per cent.; of tail only 4 per cent. We have here a case of wide range of individual variation coupled with surprising constancy of proportions. What does this mean? It means, if I interpret the facts aright, that all the species of the genus *Dipodomys* have come to a halt along a common line, like soldiers in a well-drilled regiment, indicating that in the course of their evolution from a generalized to a specialized type they have already reached, with respect to the environment and mode of life, a state of equilibrium or equipoise, from which any marked departure is injurious if not fatal. The possibilities in the way of divergence are shown by the large range of individual variation, which, however great, ceased long ago to operate in the production of new forms. All departures from the type are clearly disadvantageous and hence are promptly eliminated by natural selection. The operation of dynamic causes has resulted in the production of fixed conditions so far as the proportions are concerned—and no further modification need be looked for unless a marked change should occur in the environment.

SUBSPECIES.

It is obvious from de Vries's writings

that his studies of plants have been mainly with species as modified by man rather than with species in a state of nature. For instance, he says: "The same original form can in this way give birth to numerous others, and this single fact at once gives an explanation of all those cases in which species comprise numbers of subspecies, or genera large series of nearly allied forms." In the present connection it is necessary to notice only two of the fallacies embodied in this sweeping assertion—the two concerning subspecies. As a matter of fact, subspecies in nature do not occupy the same ground with the parent form, but an adjacent area; hence it is hard to see how they could fulfil his geographic requirement, which is that forms arising by mutation occur side by side with the original stock. And since subspecies differ from the parent form only by small differences, how can they arise from sports, which are distinguished from the parent form by large differences—differences of at least specific value?

From this it appears that de Vries's conception of subspecies and their relations in nature is somewhat hazy. In order to understand the relations and mode of origin of subspecies it is necessary to study them on the ground where they are formed, which means that it is necessary to consider them geographically. To do this intelligently one must study species in a region large enough to embrace belts of transition from one faunal (or floral) area to another, for it is in these transitional belts that the changes from one species or subspecies to another take place. The failure to recognize this simple but all important fact accounts for most of the current misconceptions concerning subspecies.[5]

[5] For present purposes it is immaterial whether subspecies are based on actual known intergradation (the point of view of the A. O. U. Code of Nomenclature) or on degree of relationship (the point of view of the morphologists and of some systematists), the material point being that they must be closely related to the parent form—either directly, or indirectly through other subspecies.

DO SPECIES ARISE INDEPENDENTLY OF GEOGRAPHIC ISOLATION?

According to de Vries: "We must conclude that new species are produced sideways by other forms, and that this change affects only the product and not the producer." Two of his seven 'laws' relate to this phase of the subject. These are: '(1) New elementary species appear suddenly, without intermediate steps; (2) they spring laterally from the main stem (not replacing it).' In thus burdening his mutation theory with the additional requirement that in giving off new forms the old is not altered, but continues to exist side by side with the new, he restricts its application to an exceedingly small number of cases, thereby materially weakening the theory itself. For in the case of the birth of a new species the new quality or character may be either neutral or beneficial. If neutral—of no value to its possessor—it is conceivable that the resulting new species may continue to exist in the same area with the old; but if beneficial the new species in the struggle for existence will eventually destroy and supplant the old—unless it diverges geographically so as to inhabit a separate area.

Dr. D. S. Jordan has recently expressed the belief that well-defined species arise only as a result of geographic isolation, but I am not sure that he means by this just what the reader might infer. His words are: "It is now nearly forty years since Moritz Wagner first made it clear that geographical isolation was a factor or condition in the formation of every species, race or tribe of animal or plant we know on the face of the earth. This conclusion is accepted as almost self-evident by every competent student of species or of the geographical distribution of species." A little

later he says: "The contention is not that species are occasionally associated with physical barriers, which determine their range, and which have been factors in their formation. It may be claimed that such conditions are virtually universal"; and again: "Given any species in any region, the nearest related species is not likely to be found in the same region nor in a remote region, but in a neighboring district separated from the first by a barrier of some sort."

J. B. Steere, in a paper on the distribution of birds in the Philippines, published in 1894, formulated the same idea in the following words: "No two species near enough alike structurally to be adapted to the same conditions will occupy the same area," and added that the facts "show *isolation* to be the first and the necessary step in the formation of species."[6]

I fully admit the potency of isolation in the production of species, but can not for a moment admit that complete isolation is a necessary factor in their evolution, mere *divarication* from a common center being in many cases sufficient. Neither can I admit that a barrier must be absolute, or that it must be interposed *between* species in order to be effective. This is proved in the case of climatic barriers, which, while not keeping contiguous species apart, nevertheless restrain each from trespassing far on the territory of its neighbor.

It is quite possible that Dr. Jordan's use of the word barrier, which occurs over and over again in his recent paper[7] is sufficiently elastic to cover most of the apparent discrepancies, so that the exceptions to his rule are really few. Still, there are in nature many groups of closely related species whose ranges follow one another in geographic series, the one beginning where the other stops, with no barrier of any kind between, as will be shown directly. In such cases it is often difficult to say whether the adjacent species have been established by differentiation from one another under existing geographic conditions, or have been developed from preexisting species along geographically divergent lines, and afterward have met by extensions of range. These points may be made clear by actual examples:

Among the kangaroo rats of the genus *Dipodomys* are two large and closely related species inhabiting our southern deserts. One of these, *D. deserti*, ranges from the Colorado and Mohave deserts in California easterly to a little east of Phœnix, Ariz.; the other, *D. spectabilis*, from a little east of Phœnix to western Texas. The geographic division between the two is an invisible line a little southeast of Phœnix in a desert area devoid of barriers of any kind, even climatic. The case, therefore, appears to be an exception to the law of isolation.

Turning now to another group, illustrations of at least two kinds of variation among closely related species are afforded by the ground squirrels of the genus *Ammospermophilus*, of which three distinct species and three subspecies are recognized. These animals resemble one another in form and markings and in the habit of carrying the tail closely appressed against the back so that its under side is uppermost and is presented to the view of the observer. In one species the under side of the tail is dark; in the others white or nearly white. The three species and their geographic ranges are (see map, Fig. 1):

Ammospermophilus nelsoni, restricted to the hot southern end of the San Joaquin Valley in California, where it occupies a detached area and is isolated by the encircling mountains, which by interposing a climatic barrier cut its range off from that of the parent species, *leucurus*. It has ac-

[6] *Auk*, XI., 239, 1894.

[7] Science, N. S., XXII., November 3, 1905.

quired a yellowish color which serves to distinguish it from all other members of the group.

Ammospermophilus harrisi, inhabiting the southwestern half of Arizona and extending south far into the state of Sonora; separated from its neighbor (*leucurus* and

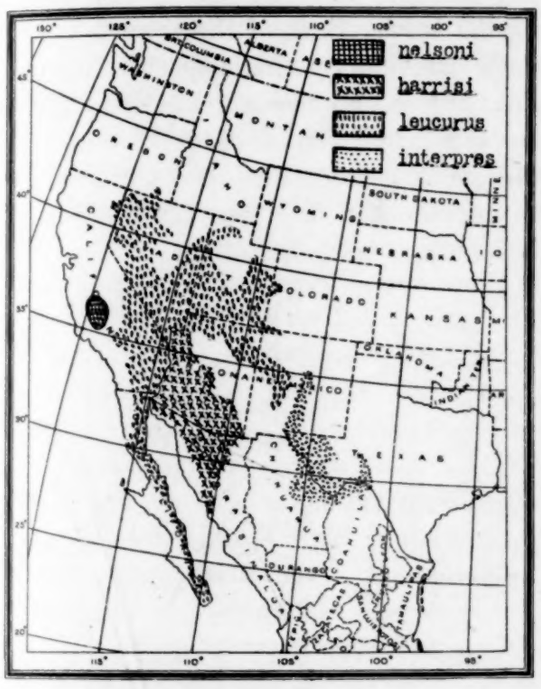

FIG. 1. Distribution of Ground Squirrels of the Genus *Ammospermophilus.*

subspecies) on the west, north and east by two kinds of barriers—on the west by the absolute barrier of the Colorado River; on the north and east, along the southern edge of the Arizona plateau and its southerly continuation in New and Old Mexico, by the climatic barrier interposed by the elevation of the land.

Ammospermophilus leucurus, inhabiting the Colorado and Mohave deserts in California and thence, passing north of *harrisi,* ranging northerly and easterly over the Sonoran deserts of the Great Basin and easterly over northern Arizona to the Painted Desert and the Puerco, where it changes into subspecies *cinnamomeus,* which continues easterly to the Rio Grande Valley near the center of New Mexico. On the opposite side of the Rio Grande (east of Albuquerque) another subspecies, *interpres,* begins and follows the Rio Grande southerly and easterly as far as the valley of the Pecos. A third subspecies, *peninsulæ,* occurs in the peninsula of Lower California. It thus appears that *leucurus,* including the subspecies, surrounds *harrisi* on three sides—west, north and east—forming a complete horseshoe open only at the south. The nature of the barriers separating it from *harrisi* has been mentioned under the latter species.

Of the three subspecies of *leucurus,* two —*cinnamomeus* and *peninsulæ*—have the under side of the tail white and are only moderately accentuated color forms, continuous in distribution with the parent form and intergrading with it by imperceptible steps. The third subspecies, *interpres,* has some black intermixed in the white of the tail, and specimens from the El Paso region, where geographically *interpres* approaches nearest to *harrisi,* have more black than specimens from near Albuquerque, suggesting the possibility that intergradation may take place in the intervening area, in southwestern New Mexico. Unfortunately we have as yet no specimens from this area. If intergradation should be shown to occur, then we shall have an example of two well-defined species occupying adjacent areas and intergrading at the point of contact while remaining distinct everywhere else. In other words, the species are perfectly distinct wherever barriers exist separating their ranges, and intergrade when there are no barriers. In distribution and behavior, therefore, these animals conform to the usual rule, that closely related species separated by impassable barriers remain distinct, while those not separated by such barriers intergrade.

But the most significant and complicated

case is that of the western chipmunks (genus *Eutamias*), one of the most elegant and attractive groups of American mammals. The genus occupies a vast area in western North America, extending from Lake Nipissing, Ontario, westerly to the Pacific Ocean, a distance of 2,000 miles, and from the Mackenzie River a little north of Great Slave Lake southward to the mountains of Zacatecas in Mexico, a distance of fully 3,000 miles. Most of the species dwell in forests, but a few inhabit the great sage brush plains. Faunally they contribute distinctive species to every life zone from the Upper Sonoran to the Arctic-continental life zones, each of which is characterized by peculiarities of climate and by a definite association of species of mammals, birds, reptiles, trees and shrubs. There are no gaps between the belts, the upper border of one being coincident with the lower border of the next, so that individual animals of different species meet along the border lines of the several zones. In some cases only a single species inhabits a zone, but in one case not less than three occur together. These three however, as would be expected, are so very distinct from one another that they could not possibly have arisen by mutation.

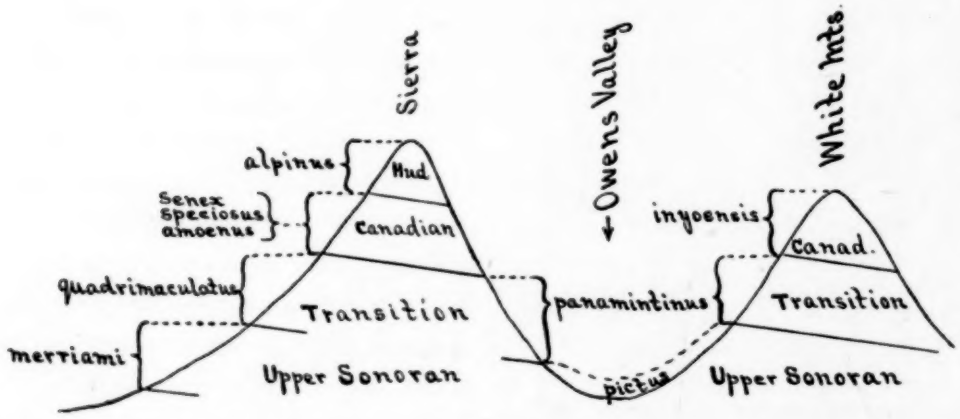

Fig. 2. Diagram Showing the Zone Ranges of Chipmunks (genus *Eutamias*) in an east-west section of the middle Sierra and White Mountains in eastern California.

Alpine. In mountainous regions the species are commonly distributed in parallel belts, the borders of which are not only in absolute contact, but even slightly overlap for long distances.

As it will be impossible in the time at our disposal to consider more than a few of the species, I have selected for illustration those that inhabit eastern California, along an east-and-west line extending from the west base of the Sierra Nevada to the summit of the White Mountains. On the gradually rising slopes of the Sierra the species are arranged one above the other, from base to summit, in definite belts or strata (see diagram, Fig. 2). Field studies have shown that these belts are the same as the trans-

Beginning at the foot of the Sierra on the west side, the first species encountered is a large, dark, long-tailed form (*Eutamias merriami*), whose range coincides with the limits of the digger pine or Upper Sonoran zone. Immediately above this is the broad belt of ponderosa pines and giant sequoias of the Transition zone. The chipmunk of the zone below does not occur here, but is replaced by a striking long-eared species (*quadrimaculatus*) which fills the zone and is restricted to it. Along the line where the yellow pines of the Transition zone change to the Murray pines of the Canadian no less than three species (*amœnus, senex* and *speciosus*) begin abruptly and range upward throughout the Canadian

zone. Above this still is the Hudsonian zone, and it also has its distinctive chipmunk—a small but highly colored species (*alpinus*)—which fills the zone completely and climbs up a short distance on the alpine slopes above timber line. Crossing the summit and descending the steep east side of the Sierra, the Canadian zone is found to be inhabited by the same three species that occupy this zone on the west slope. Below this, in the nut pine belt of the Transition zone, is a brilliantly colored species (*panamintinus*) very different from any we have seen. Still lower, in the Upper Sonoran sage brush of Owens Valley, is a small gray species (*pictus*) not related to any of the others. Owens Valley is a long narrow and deep valley between the Sierra and the White Mountains. Crossing this valley and ascending the west slope of the White Mountains we reenter the nut pine belt and find the same chipmunk (*panamintinus*) that we found in the same belt on the other side of the valley (on the east slope of the Sierra). Continuing the ascent we enter the Canadian zone, which covers the greater part of the summit of the White Mountains, and in it find a widely different chipmunk (*inyoensis*), which proves to be another member of the beautiful *speciosus* group—a group we have already found represented in the same zone on both east and west slopes of the Sierra.

Thus in a distance of a hundred miles, from the west base of the Sierra to the summit of the White Mountains, are included the ranges of no less than nine species of chipmunks. This is made possible by the height and steepness of the mountains, the abrupt changes in altitude with consequent differences in temperature compressing the life zones into narrow parallel belts; whereas in level regions, as well known, these same belts are spread out broadly over the land.

The Sierra chipmunks furnish striking illustrations of the *occurrence* of species without isolation, and some of them of the *evolution* of species without isolation, for not only are there no visible barriers between the ranges of adjoining species, but the species themselves actually overlap along the zone borders, individual animals belonging to the zone above and the zone below occurring together on the same ground. But while there are no barriers *between* the species, each belongs to and is characteristic of a definite climatic life zone; and the fact that the life zones overlap slightly along the edges explains the slight geographic overlapping of the species themselves. The reason the species do not intergrade along the lines of contact doubtless is that they are not closely enough related—their differentiation into fully developed species (with the probable exception of *speciosus* and *inyoensis*) having taken place long ago.

The question now arises as to the origin of the nine species. Most of these, if studied independently of their relations in other parts of the country, resemble one another sufficiently to justify the inference that they have been derived from one another.

Far from holding this view, however, my belief is that some of them came from closely related forms in remote geographic areas, others from antecedent forms now extinct, and not more than three or four from species still inhabiting the region. The case is of a class often encountered by the systematist and student of distribution, where, without a comprehensive knowledge of the relationships and geographic distribution of the group as a whole and of its component species and subspecies, there is little hope of arriving at correct conclusions. Let us look closely at the facts, for they have an important bearing on more than one problem in evolution and distribution.

The Hudsonian species *alpinus*, now restricted to the lofty crest of the southern High Sierra, appears to be distantly related to *oreocetes* of Montana, but has no near relative.

Another of the Boreal species, *amœnus*, ranges northward over the Cascades in Oregon and is only subspecifically distinct from a form inhabiting the boreal forests of the Rocky Mountains in Colorado.

The *speciosus* group, it will be remembered, is represented in the east California section by two forms (*speciosus* and *inyoensis*), which may be called species or subspecies, as you like—the fact being that they are more closely interrelated than are any of the other forms of the region, although intergradation has not been proved. But instead of occupying different faunal zones, as do the other species, they occupy different parts of the same zone—*speciosus* inhabiting the Boreal slopes of the Sierra, *inyoensis* the corresponding Boreal crest of the adjacent White Mountains (here separated from *speciosus* by the Upper Sonoran and Transition zones of Owens Valley). But where did the *speciosus* type come from? Investigations carried on by the Biological Survey show that the same specific type still inhabits the upper slopes of the San Bernardino and San Jacinto Mountains in southern California, that a more distantly related form (*quadrivittatus*) occupies the Transition zone in Colorado, and that between the two, on an isolated mountain peak rising from the arid deserts of southern Nevada, is another species (*palmeri*), more strongly differentiated in consequence of local peculiarities of environment. These facts show not only that the *speciosus-quadrivittatus* group is a very old one, but also that its ancestors once inhabited the Great Basin itself. In those days the arid deserts of this region were in their infancy, and must have been completely bridged by continuity of coniferous forests, connecting the Sierra and Rocky Mountain areas.

The Desert Range species, *panamintinus*, which occupies the Transition zone on both sides of Owens Valley, occurs south of the White and Inyo mountains in the Coso and Argus mountains, and farther east, in the Panamint, Grapevine, Providence and New York mountains in the desert region of eastern California, and on Mount Magruder in western Nevada. It belongs to a group of which only one other species is known—*E. hopiensis*, of the high desert mesas of northeastern Arizona, southeastern Utah and southwestern Colorado. In this case, as in that of two other groups already discussed (the *amœnus* group and the *speciosus-quadrivittatus* group) the range of the type comprises localities on both sides of the Great Basin. It appears to be an aberrant offspring of the *speciosus-quadrivittatus* group and probably originated from the ancestors of that group in the bygone days when they inhabited the ancient forests of the Great Basin.

Eutamias senex appears to have originated in the Siskiyou Mountains, on the boundary between California and Oregon, as an offshoot from the redwood chipmunk, *ochrogenys*—which in turn is closely related to *townsendi* of the northwest coast of Oregon and Washington. From the Siskiyous, *senex* ranges north along the Cascades nearly to Mt. Hood, and south in the Sierra to the latitude of Yosemite Valley. In time it may be expected to push on to the south end of the Boreal Sierra in the Mt. Whitney region. *E. senex* appears to be the parent form, directly or indirectly, of two other species—*quadrimaculatus* and *merriami*—whose ranges now occupy considerable stretches along the flanks of the Sierra. It seems probable that *quadrimaculatus* originated near the north end of its present range and under existing geographic and climatic conditions. While,

as we have already seen, it occupies the Transition zone, directly below the Boreal zone inhabited by *senex,* and while the ranges of the two are in direct contact for many miles, both species remain true, showing no tendency to intergrade. The history of *merriami* is by no means so simple, and the road by which it reached its present home by no means so direct. It is not an immediate offshoot from *senex,* for before attaining its present status it passed through another form, known as *pricei.* The story, as I interpret it, is this: In the northern part of California, south of the Siskiyous and west of the northern Sierra, the Boreal *senex* gave off a Transition zone form which spread and became differentiated in two directions: to the southward along the west flank of the Sierra it developed long ears and the peculiarities of coloration that distinguish *quadrimaculatus;* to the westward it developed the long tail and other peculiarities that distinguish *pricei.* The latter pressed southward through the coast ranges to Monterey Bay, south of which it underwent another change, assuming the characters by which *merriami* differs from *pricei,* and continued in the same direction to the Santa Barbara Mountains, and then easterly to Mt. Pinos, where its range forked, the north branch following the Tejon and Tehachapi Mountains to the southern Sierra and thence northward to a little beyond the Yosemite; the south branch pushing southeasterly over the Sierra Liebre, Sierra Madre, San Gabriel and San Bernardino mountains, and then south over San Jacinto and Palomar to the San Pedro Martyr Mountains of Lower California. In the Sierra region *merriami* is restricted to the Upper Sonoran zone, while its immediate ancestor, *pricei,* belongs to the Transition zone, and its remoter ancestor, *senex,* to the Boreal zone. The change from Boreal *senex* to Transition zone *pricei* and *quadrimaculatus* is merely a zone adaptation to an immediately adjoining area; the change from *pricei* to *merriami* is simpler and at the same time more interesting, for the belt occupied by *pricei,* while mainly Transition, possesses the climatic peculiarity of mild winters and relatively cool summers and fulfils the temperature requirements of both Transition and Upper Austral zones, permitting an overlapping or admixture of the distinctive species of both. In this belt *merriami* became adapted to Upper Austral conditions, so that in extending its range back to the Sierra it was natural that it should adhere to the Upper Sonoran zone.

The three Sierra members of the *senex* group (*senex, quadrimaculatus* and *merriami*) therefore have reached their appropriate zones from opposite directions—*senex* and its offshoot *quadrimaculatus* from the north by direct continuity of range; *merriami* from the south (after passing through another form) by the roundabout way of the Coast ranges and the Tejon and Tehachapi mountains.[8]

To sum up the story of the California chipmunks from the standpoint of their geographic origin: Of the nine species inhabiting the middle Sierra region, six (*senex, amœnus, speciosus, merriami, panamintinus* and *pictus*) appear to have come in from contiguous territory in their present condition—as fully formed species—although it is possible that one of them (*amœnus*) originated here and extended its range northward; and three (*quadrimacu-*

[8] The chipmunks afford admirable illustrations of a number of phases of variation and distribution besides those here discussed—as the occurrence of closely related forms end-to-end in the same zone; the spreading out of a species in certain parts of its range to cover an adjacent zone which elsewhere is avoided; the development of protective and directive coloration and markings; the utility or non-utility of characters used in the discrimination of species, and so on.

latus, inyoensis and *alpinus*) appear to have been developed within the region in the areas they now inhabit. So far as origin is concerned, therefore, we have to do with only the last three. Of these, one —*inyoensis*—was clearly derived from the *speciosus* stock by the gradual accentuation of minute variations; another, *quadrimaculatus,* appears to have originated from *senex* in the same way, as already explained, leaving only one, *alpinus,* whose *history* is by no means obvious. Since *alpinus* has no near relatives, there is little in the way of a clue to its ancestry. As already suggested, it may be the remnant of an Arctic-Alpine group, of which it and *oreocetes* of the high mountains of western Montana are the sole survivors. In any case its origin must be sought far back in the past.

I have dwelt thus at length on the California chipmunks for three reasons: (1) The problems they present to the student of variation and evolution are fairly representative of problems presented by other groups; (2) the compact distribution of the species in close-lying parallel belts in conformity with the life zones has the advantage of bringing them into near relations, so that the facts of variation and behavior are easily discerned; (3) the study of the group emphasizes the necessity of a knowledge of the geographic distribution of species in order that their interrelations and probable origins may be understood.

The term geographic distribution must not be taken to mean merely the area a species occupies, to be shown by a color patch on the map, but includes a comprehensive knowledge of the geographic environment, taking into account the climate and the aspects of nature with which each species is associated and by which it is profoundly impressed. Moritz Wagner, in a paragraph recently quoted by Doctor Jordan, said: It is 'the study of all the important phenomena embraced in the geography of animals and plants, which is the surest guide to the study of the real phases in the process of the formation of species.' To the systematist and student of evolution this knowledge is so fundamental that it is hard to see how correct conclusions can be reached without it. In studying problems in nature the geographic point of view is the natural method of approach; it is a method so full of suggestions and explanations that we can ill afford to do without it. And how can it be otherwise, for do we not all admit that organisms are profoundly affected and modified by their environment? The utter hopelessness of attempting to work out the variations, affinities and probable origin of a group of related species of animals or plants without giving heed to the geographic distribution of the various forms has just been illustrated by the case of the Sierra chipmunks. If to a knowledge of present distribution can be added a few facts from the paleontological history of the group a flood of light is at once thrown on the problem.

INTERGRADATION AND REGIONAL INFLUENCES.

In studying geographic variation in the various groups of terrestrial animals and plants one soon learns that among closely related species and subspecies some forms intergrade while others do not; and that among those that do intergrade, the change from one to another may take place abruptly in a narrow belt, or gradually, by imperceptible steps, over a wide area. These two kinds of intergradation do not usually occur in the same area, for the reason that each is associated with a definite set of geographic and physiographic conditions of which climate plays the most important part. As a general rule it may be asserted that where the geographic change from one faunal area to another is gradual,

the change in the species is gradual; and conversely, where the geographic change is abrupt the change in the species is abrupt. Changes in a north-and-south direction are likely to be gradual; those in an east-and-west direction are likely to be more abrupt. In both cases, the controlling power of environment is easily recognized. It follows that one species does not change here, another there; the rule—to which there are exceptions—is that all change in a common belt or area. It thus comes about that American students of species, from Baird's time to the present, have learned to recognize certain geographic areas, usually in the form of belts, where the transition from one set of animals and plants to another set takes place. These belts of intergradation, broad or narrow as the case may be, are always flooded with intergrades, which, though the bane of the museum man, are of great importance to the student of variation and evolution.[9]

In order to make the matter perfectly clear—for it is one of no small importance to evolutionists—let me cite a few examples.

The common prairie ground squirrel or striped spermophile (*Citellus tridecemlineatus*) splits up into four geographic forms or subspecies. The range of the species as a whole extends from the plains of the Saskatchewan on the north to the coast of Texas, and from the extreme eastern edge of the prairie country in the Great Lake region westerly to and a little beyond the Rocky Mountains (see map, Fig. 3). Typical *tridecemlineatus* occupies the eastern and more humid part of this area. In ranging westward it undergoes a change, becoming paler and smaller as it enters the arid plains. The change occurs between the one-hundredth and one hundred and first meridians, from South Dakota to middle Texas, and the resulting pallid form (subspecies *pallidus*) continues westerly to the foot of the Rocky Mountains. In passing southward from the Upper Austral to the Lower Austral zone *tridecemlineatus* develops another form (subspecies *texensis*), which occupies a broad belt in Oklahoma and eastern Texas, east of the range of subspecies *pallidus*. But this is not all, for the plains form (*pallidus*) in pushing westward over some of the passes of the Rocky Mountains gives off still another subspecies (*parvus*), which occupies the Green River Basin in Wyoming, and extends thence southerly in an irregular and interrupted belt along the border between Colorado and Utah, and occurs in isolated colonies in New Mexico and extreme eastern Arizona. Between these several forms are the belts of intergradation, as shown on the accompanying map (Fig. 3).

The case is one in which a well-marked species splits into four geographic forms or subspecies in conformity with the climatic and physical features of the region inhabited. Each form is fairly constant throughout the major part of its range and develops intergrades in the transitional belt between it and the next form.

Among North American mammals and birds there are hundreds of such cases, and more than 1,000 species and subspecies, connected with other forms by series of intergrades, might be enumerated.

It may be set down as a general law that wherever a species or subspecies passes into another, intergrades occur, not side by side

[9] Among the belts of this kind are the overlapping boundaries of the life zones and certain other lines which mark the change from one physiographic or physiognomic type to another. Among these may be mentioned a strip along the western edge of the deciduous forests, where woodland gives place to prairie; a belt near the ninety-ninth meridian, where the humid prairies change to the arid plains; a belt along the east base of the Rocky Mountains, where plains forms change to mountain forms; and similar or corresponding areas in the Great Basin and in the interior of California.

with the typical form, but replacing it in the territory between it and that occupied by the new form, so that as a rule all the individuals from the transitional territory are intergrades. This fundamental fact in geographic biology seems to have escaped the keen eye of Darwin, who, in speaking of the difficulties and obstacles in the way of his theories, said:

"Why, if species have descended from other species by fine gradations, do we not everywhere see innumerable transitional forms? Why is not all nature in confusion, instead of the species being as we see them, well defined?" One of his critics, Thomas Hunt Morgan, thinks this a very serious matter. My reply to both Darwin and Morgan is that they are mistaken in their premises, for in nature transitional forms are so abundant as to be a source of annoyance and embarrassment to systematists and museum curators—men who are continually handling specimens which they desire to refer to one species or another. The only explanation I think of to account for Darwin's and Morgan's failure to recognize this fact is limited or unfavorable field experience, and limited experience in handling specimens from the peripheries of geographic areas large enough to cover the transition from one faunal division into another—in other words, failure to study the behavior of species in nature from the geographic standpoint. One might spend a lifetime in studying animals and plants in the interior of almost any of the faunal areas without encountering transitional forms or intergrades, for it is at the peripheries or borders of these areas that the intergrades occur. It would seem, therefore, that Darwin, in his effort to present fairly all objections to his theory, imagined a difficulty which does not exist, and that his critic Morgan solemnly shook his head at a man of straw.

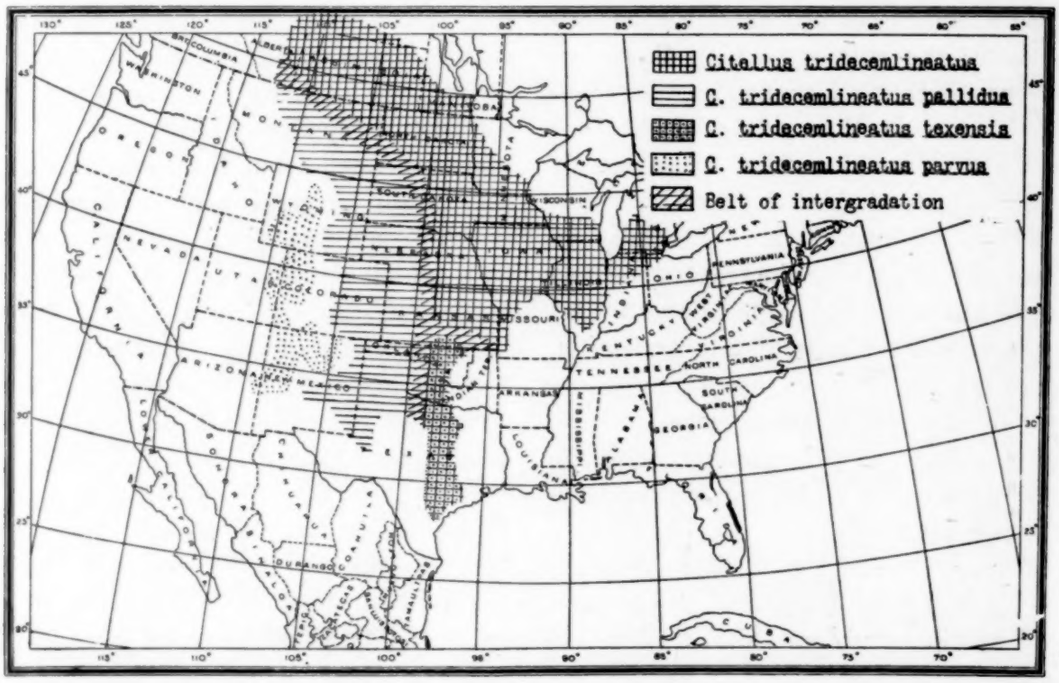

Fig. 3. Distribution of the Prairie Ground Squirrel, *Citellus tridecemlineatus* and subspecies.

Conclusion.—Inasmuch as all species have their beginnings in variations, and

inasmuch as sudden or sport variations are exceedingly rare while slight variations are exceedingly common, does it not follow that the vast majority of species must originate from slight variations? My argument is not that species of plants may not in rare cases arise by the perpetuation of sport characters, as de Vries believes they do, but admitting this, my contention is that the overwhelming majority of plants, and so far as known all animals, originate in the generally recognized way, by the gradual development of minute variations. The theory of the origin of species by mutation, therefore, far from being a great principle in biology, as some seem to believe, appears to be one of a hundred minor factors to be considered in rare cases as a possible explanation of the origin of particular species of plants, but so far as known not applicable in the case of animals.

C. HART MERRIAM.
U. S. BIOLOGICAL SURVEY.

SECTION F—ZOOLOGY.

SECTION F was organized at the New Orleans meeting with the following officers:

Vice-President—Henry B. Ward, Lincoln, Nebr.
Secretary—C. Judson Herrick, Granville, Ohio.
Councilor—Herbert Osborn.
Member of General Committee—B. L. Seawell.
Press Secretary—C. Judson Herrick.
Sectional Committee—C. H. Merriam, Vice-president, 1905; Henry B. Ward, Vice-president, 1906; C. Judson Herrick, Secretary, 1905–6; C. H. Eigenmann, for one year; Henry B. Ward, for two years; Frank Smith, for three years; W. E. Ritter, for four years; A. M. Bleile, for five years.

On the afternoon of December 29 the vice-president's address was delivered by C. H. Merriam, on the subject, 'Is Mutation a Factor in the Evolution of the Higher Vertebrates?' The section met for the reading of papers on December 30, and joint sessions were held on January 1 with the Section of Physiology and Experimental Medicine, and on January 2 with the Association of Economic Entomologists. The following papers were read before the section:

Preliminary Observations on the Variation of Utethesia venusta, Dalman: MEL. T. COOK, Santiago de las Vegas, Cuba.

The literature recognizes three species (*U. bella, U. venusta* and *U. ornatrix*) and three varieties (*hybrida, terminalis* and *stretchii*) of this genus. These species cover a very wide range. The distinctive characters are primarily color characters. After examining a large number of specimens, many of which were reared in captivity, the writer concludes that intergradations are such as to reduce these three species and three varieties to one species.

Filaria loa, a Study on the Dispersal of Parasites: HENRY B. WARD, University of Nebraska.

Of the African eye worm (*Filaria loa*) the author has recently published a list of 86 old and 8 new cases. The first six cases on record were from the West Indies, as also twelve in the first 21. But since 1845 no cases have been recorded there, its introduction having ceased with the cessation of the slave trade. All cases were in negroes and most had recently come from West Africa. Five cases reported from France all originated in the French Congo, as also cases from Switzerland and Belgium. One specimen removed in Germany came from Kamerun, and five in England from Old Calabar.

Eight cases in North America since 1890 were all in missionaries and all but one came from Kamerun. Thus all extra-African cases are distinctly traceable to a known or a possible infection in the western part of that continent where the parasite is endemic. Here the review of cases indicates clearly that the parasite is distributed over the entire coast from about

5° north of the equator to at least 10° south, and various observers say that in certain regions nearly every inhabitant suffers from it. This is recorded for the Ogowé River by Miss Mary Kingsley, the well-known African traveler.

How far it may penetrate into the interior of the continent is as yet unknown. Certain it is, however, that cases occur more than 120 miles from the coast, while a recent paper records its presence in a post-mortem made in Kassai, approximately 600 miles from the coast on one of the chief tributaries of the Congo.

The occurrence of *Filaria loa* in negro slaves, in travelers, in government officials and in missionaries points out distinctly the certainty with which any kind of intercourse between nations and geographic areas tends to transfer to new races and territories the diseases of the old. Increased means of communication and growing freedom of movement contribute clearly to the spread of maladies and call for better means to check their advance into new regions. It is not to be doubted that some of the persons who brought *F. loa* into the United States now harbor its embryos in the blood. Though we know nothing precise of its life history, the possibility lies close at hand that some blood-sucking insect may furnish these embryos proper conditions for further development and may thus bring about the introduction of a new disease into our territory. Such cases as these of *F. loa* show clearly the gradual spread of disease through national intercourse.

A New Bothriocephalid Parasite of Man: Henry B. Ward, University of Nebraska.

The specimens were obtained from a child six years of age, born and brought up in the prairie region. The report of the mother that the child had been found some months ago chewing a piece of raw fish probably serves to explain the mode of infection. The specimens do not belong to the common bothriocephalid found in man (*Dibothriocephalus latus*), but to another species apparently undescribed as yet. A complete account of the anatomy of the species will be published later, together with a discussion of its relationship.

An American Species of Lumbriculus Grube: Frank Smith, University of Illinois.

The species, *Lumbriculus variegatus* (Müller) is the best known representative of the family Lumbriculidæ and is the only recognized member of its genus. It has thus far been found only in Europe. Recent papers by Wenig and Hesse have extended our knowledge of the reproductive organs of that species and have lessened the supposed differences between it and *Thinodrilus inconstans* Smith, described in 1895 from Illinois specimens. After a further study of these specimens, the writer is convinced that the Illinois specimens should be included in the genus *Lumbriculus*. The details of structure and comparison on which this conclusion is based appear in the paper which will soon be published in the Bulletin of the Illinois State Laboratory of Natural History.

A Mendelian Character in Cattle: W. J. Spillman, U. S. Department of Agriculture.

The data presented indicate that in crosses between polled and horned cattle the inheritance of the horn-producing character is in accordance with Mendel's well-known law of segregation of character pairs. The paper was based on the progeny of seven polled bulls bred to horned cows. The polled character is dominant, though the hybrids frequently have 'scurs'—imperfectly developed horns.

The Activity of the White Rat at Different Ages: JAMES ROLLIN SLONAKER, Stanford University.

Three preliminary experiments have been carried on and others are in progress to determine the normal daily activity of the white rat from birth to natural death due to old age. The rate of growth as determined by weight and the daily activity as determined by the number of revolutions of revolving cages are carefully recorded and tabulated. From the preliminary experiments the following conclusions may be drawn:

1. A marked difference in daily activity is noticed in rats of different ages.

2. The very young rat and the old rat are each noticeably inactive.

3. The period of greatest activity appears to be when the rat has reached the age of 100 days. At this age the weight is but little more than half that of the adult.

4. The period of daily activity occurs almost wholly during the night-time. They show little or no activity during the day-time. This, I think, is due mainly to the anatomical structure of the eye and to inherited tendencies.

5. The curve of activity rises gradually until the rats have reached about the age of forty or fifty days, after which there is a very rapid ascent.

6. Great individual variations are manifested, which necessitate experimenting on a larger number of individuals.

7. Owing to the premature termination of these preliminary experiments, a curve representing the activity from birth to death due to old age could not be constructed. Experiments now in progress will furnish the data for such a curve.

The Physiological Effects of Changes in Water Density and Salinity on Fishes: F. B. SUMNER, College of the City of New York.

The Poison Glands of Noturus and Schilbeodes: H. D. REED, Cornell University.

The Osteology and Relationships of the Percopsidæ: H. D. REED, Cornell University.

Descriptions of a New Genus and Nine New Species of Sphæromidæ: HARRIET RICHARDSON, Smithsonian Institution.

In this paper a number of new species belonging to several well-known genera are described, and diagnoses of genera heretofore established are more fully drawn up, together with the definition of a new genus, *Cassidias*. The species described come from off Cape St. Roque, Brazil; off Rio de la Plata, Argentine Republic; from Hakodate Bay, Japan, and Cape Town, Africa. The types of all are in the collection of the U. S. National Museum. A few remarks are offered in regard to the species of the genus *Tecticeps* and both *T. alascensis* and *T. convexus* are redescribed and additional figures given.

The Embryology of Corymorpha: HARRY BEAL TORREY, University of California.

Fertilization is external; the eggs are amœboid until fertilized. Cleavage is approximately equal. The gastrula cavity is formed between the cells of a solid endodermic mass of planula. The latter is never ciliated and has no free-swimming stage, but may creep slowly. The hydranth is formed by a *transformation* of the distal half of the embryo; the axes of the tentacles arise from cells pushed out from the epithelial endoderm. Rootlets appear similarly. Tentacles arise according to a modified quartet plan governed probably in large measure by mechanical conditions. Cœnosarcal canals, numerous in the adult, are derived from a single larval cavity by ingrowth and enlargement of epithelial endoderm cells. Morphallaxis plays an important rôle in development.

The Relation between the Nerves of Taste and Touch in Fishes: C. Judson Herrick, Denison University.

It has been shown that certain teleosts, notably catfish and carp, are provided with taste buds freely distributed in the outer skin, that the fishes taste with these organs and habitually localize their food by the combined action of cutaneous organs of touch and taste. Inasmuch as these sense organs belong to totally distinct systems (somatic and visceral, respectively) whose peripheral nerves and primary cerebral centers are wholly unrelated, considerable interest attaches to the question of the central relations of the tactile and gustatory systems of neurones with one another. The gustatory reflex paths within the brains of these fishes have been fully worked out, and the present paper reports the discovery of a broad and complex area of correlation with the tactile centers in the funicular nuclei at the lower end of the medulla oblongata.

The Problem of Wing Origin and its Significance in Insect Phylogeny: Herbert Osborn, Ohio State University.

The origin of the insect wing is a difficult problem to solve, since on account of its antiquity the evidence, both morphological and developmental, is much obscured. Fossil forms show the occurrence of winged insects as far back as the Paleozoic, and the structure must, of course, have arisen at some time prior to or during that period. The reduction of types of venation to a common form indicates a common origin for wings of all orders, and the inclusion of tracheæ suggests a respiratory function. A respiratory function indicates aquatic life in the ancestral form, a suggestion which is corroborated by the method of musculature and the development so far as it can be traced. That they are not to be associated with any existing forms of aquatic insects is believed to be shown by the secondary character of aquatic adaptation of modern orders. The explanation of aquatic origin becomes conceivable, however, if we assume a primitive tracheate form, perhaps peripatoid in character, which became adapted to aquatic life before or during Paleozoic time, this primitive aquatic form returning to terrestrial habit and the tracheated respiratory gills being modified to wings. Of the existing orders then arising, some have become in part or quite entirely aquatic by adaptation in more recent time. Diagrams indicating the appearance of the different orders of insects in time and their lines of derivation as suggested by this conception of the evolution of the Pterygota were shown.

C. Judson Herrick,
Secretary.

SCIENTIFIC BOOKS.

The Elements of Psychology. By Edward L. Thorndike. Pp. xix + 351. New York, A. G. Seiler. 1905.

Hardly a year passes now-a-days without the appearance of several new text-books of psychology. One's first impression in noting this fact is that there must be as yet in this still youthful science comparatively little agreement among its individual expositors as to the body of facts to be presented, or as to the laws which account for the existence of the facts, or as to the best manner of presentation. Professor James, indeed, in a justifiably laudatory introduction to this book by Thorndike, maintains that these many text-books "so far as students go, are practical equivalents for each other. * * * The differences in them are largely of order and emphasis, or of fondness on the authors' parts for certain phrases, or for their own method of approach to particular questions. It is one and the same body of facts with which they all make us acquainted." This is certainly true. There is a large body of facts with respect to which there is general agreement. Yet after all, the mere presentation of facts

in their isolation is one of the least important of the functions of a text-book. What are the great all-embracing laws which bind these facts together into the orderly unity of an individual life and of the universe of conscious facts; what is the solution of the old disputed problems concerning determinism and indeterminism, parallelism and interaction; what are the ultimate elements out of which every moment and kind of consciousness is constructed, and in what sense do they exist; which ones of the established and of the assumed facts need emphasis in order to convince the elementary student of the truth of these unifying principles, and to make his knowledge of laws and of facts of real value to him by enabling him to better understand his daily life—these are questions of fundamental importance to the very existence of psychology as a true science, and are yet the very ones in regard to whose solution there does not seem to be practical agreement among psychologists. That the teachers of the science feel this is evidenced both by the number of them who publish text-books of their own, and by the eagerness with which, if we may trust the announcements of publishing firms, a new text-book is adopted widely in the hope that it may prove more satisfactory than the last.

These matters of ultimate theory and of emphasis are apparently of decisive importance in determining the selection of a text-book; and the ideal text-book in these respects seems not yet to have appeared. To the present reviewer Professor Thorndike's book seems to approach it in more important respects than any other. The reviewer regrets the absence of any or sufficient discussion of many principles and facts that seem to him of essential importance. But it would be only on grounds of preferred emphasis that he would criticize the book, and as this is purely a matter of individual opinion, criticism may well be dispensed with, and the more striking merits of the book alone pointed out.

The book is designed, as its author says, 'to serve as a text-book for students who have had no previous training in psychology, who will not in nine cases out of ten take any considerable amount of advanced work in psychology, and who need psychological knowledge and insight to fit them to study, not the special theories of philosophy, but the general facts of human nature.' Professor Thorndike is a born teacher, as well as an able investigator, and he has accomplished his task well. His treatment of the subject is given under three main headings. In Part I, he deals with descriptive or structural psychology and in it 'the rich variety of human thought and feeling is shown to be divisible into three natural groups: first, feelings of direct experience; second, reproductions of direct experience; and third, feelings meaning or referring to direct experience.' This is, perhaps, in its analytical thoroughness, the least satisfactory portion of the book. In Part II. he discusses 'the tremendously complex physical basis of mental life, the nervous system,' with the aid of numerous photographs and drawings, in accordance with the most recent views, and with the aim of furnishing the student with a conception of it which shall be truly explanatory with reference to mental facts. Part III. is concerned with dynamic or functional psychology, and presents admirably the laws which account for the psychologically important bodily activities, and for the occurrence and sequence of mental states. In his selection and manner of statement of the facts he is throughout apt, clear and connected. In addition to the simplicity and clearness of his account, one is struck forcibly and favorably by the wealth of helpful illustrations, of practical applications and of useful and well-chosen exercises. Any teacher of psychology who, instead of preparing a text-book for himself, prefers to use that of some one else, supplemented by his own lectures, may feel confident that no other is better suited to his purpose than this. It not only ensures to the student a clear grasp of the science as a theoretical whole, but is well calculated to make it vital and real to him, and helpful in the understanding and conduct of his own practical life.

EDMUND B. DELABARRE.
BROWN UNIVERSITY.

Radio-activity. By E. Rutherford, D.Sc., F.R.S., etc. Second edition, 1905. Cambridge, The University Press; New York, The Macmillan Co. Cambridge Physical Series. Edited by F. H. Neville, F.R.S., etc., and W. C. D. Whetham, F.R.S., etc. 8vo. Pp. xiv + 580. Price $4.00.

It is but a short time ago since the first edition of this work (1904) was reviewed at length in these columns. The rapid appearance of a second edition is characteristic of the energy of the author; but it also bespeaks the intense interest which the subject has aroused and the adequacy with which the demand has been met by Mr. Rutherford. The new treatise gives evidence of the same skilful presentation and arrangement as the old, though there has been expansion in bulk from 389 to 580 pages. Among the more conspicuous novelties are the chapters on the transformation products of uranium, thorium, actinium, radium and on the rate of emission of energy. In other chapters the recent growth of our knowledge of the alpha rays is noteworthy. The book is provided with an excellent index.

The present very carefully edited work of Professor Rutherford, together with the two ponderous volumes of original papers just issued on behalf of the French Physical Society by MM. H. Abraham and P. Langevin, not to mention other sources, places the whole domain of radio-activity within easy reach of the student. All this information is virtually given at first hand. What remains to test his endurance is the ever-growing mass of research with which the subject is barricading itself, and the increasing difficulties of treatment.

C. Barus.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for January is an unusually interesting number, being devoted to live, or living, subjects. The first article on 'Flying-fish Flight, and an Unfixed Law of Nature,' by C. D. Durnford, brings forward evidence to support the views of those who believe that the flight of this fish is active and not purely a sail. It may be said that this view is held by many good observers and that additional testimony may be found in *Forest and Stream* for January 27. G. H. Parker discusses 'Double Hen's Eggs,' concluding that they are due to the retention of an egg in the oviduct and its surrounding by a second. W. A. Cannon treats of the 'Biological Relations of Certain Cacti,' including their root structure and adaptations for the absorption and storage of water. H. Drexler and L. Freund present some welcome 'Contributions to [our knowledge of] the Physiology and Biology of the Dugong,' a common but little-known animal. There is a notice of a congress of oceanography to be held this year at Marseilles.

The Journal of Comparative Neurology and Psychology for January contains an article of 109 pages, with 16 plates, on 'The Structure of the Teleostean and Selachian Brain,' by Dr. C. U. Ariens Kappers, of Amsterdam, comprising as complete a description of the microscopic anatomy of these brains as could be made from Weigert sections, together with full digests of all important literature. Such a comprehensive study has long been needed and will probably serve as the point of departure for more special studies in the neurology of fishes for a long time.

Popular Science Monthly for February contains the following articles:

Charles Keyser Edmunds: 'The Passing of China's Ancient System of Literary Examinations.'

Joseph Jastrow: 'The Lapses of Speech.'

Edwin W. Bowen: 'What is Slang?'

S. Tetsu Tamura: 'Recent Advances in Meteorology and Meteorological Service in Japan.'

Ernest W. Brown: 'With the British Associatio in South Africa.'

C. A. Miller: 'Some Recent Tendencies in Mathematical Instruction.'

A. C. Lane: 'The Wealth of the Commonwealth, its Consumption and Conservation.'

W. Le Conte Stevens: 'The Honor System in American Colleges.'

The Bulletin of the South Carolina College for January, the most recent addition to museum publications, deals with the rehabilitation of the museum of that institution and includes articles on various branches of mu-

seum work. The chapter on 'The Mineralogical and Geological Cabinets,' by D. S. Martin, contains many interesting references to Cooper, Le Conte, Holmes and others of our earlier mineralogists and geologists.

SOCIETIES AND ACADEMIES.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 610th meeting, the 35th annual meeting, was held on December 30, 1905, President Littlehales in the chair.

The report of the secretaries showed 126 members on the active list, a small net gain during the year, and 74 on the absent list.

The report of the treasurer showed an income of $802.19 and expenses of $413.27 during 1905.

The following officers were elected for the year 1906:

President—Cleveland Abbe.

Vice-Presidents—A. L. Day, E. B. Rosa, L. A. Bauer and J. F. Hayford.

Treasurer—Bernard R. Green.

Secretaries—C. K. Wead and G. K. Burgess.

General Committee—W. A. DeCaivelry, W. S. Eichelberger, L. A. Fischer, C. Adler, R. A. Harris, J. Page, C. G. Abbot, L. J. Briggs and I. Winston.

To this committee there will be added such of the past-presidents residing in Washington as shall consent to serve on it.

THE 611th meeting was held on January 13, 1906, President Abbe in the chair.

Mr. C. G. Abbott read a paper on 'A Standard Pyrheliometer and its Use on Mt. Wilson in California.'

Three independent lines of research are being carried on by the Smithsonian Astrophysical Observatory to determine if the output of solar radiation is variable. One of these consists in obtaining values of the 'solar constant' of radiation outside our atmosphere, by the spectro-bolometric method of homogeneous rays practised many years ago by Mr. Langley on Mt. Whitney. The author was in charge of a Smithsonian Observatory expedition to Mt. Wilson in California to determine solar constant values during the past summer and autumn, and had with him a complete duplicate of the outfit simultaneously used for the purpose in Washington.

Measurements by the pyrheliometer or actinometer of the total radiation reaching the surface of the earth are necessary, as well as spectro-bolometric observations. Distrust was entertained of the accuracy of all instruments heretofore proposed as standard actinometers or pyrheliometers, for the reason that the rays are always received upon a front, or outside surface, while the measurements of temperature are made behind or within. Hence the absorbed heat has a path of direct escape to the surroundings and no allowance for this can be made either by cooling corrections, by reading with the temperature recording apparatus at the temperature of the surroundings or otherwise. In illustration, the nature of the error in the instruments of Pouillet, Ångstrom, Nichols and Hull and others, was pointed out.

No easy method of determining the magnitude of the error being found, a new instrument in which the rays are absorbed at the conical rear end of a tube-like blackened and diaphragmed chamber was devised. This chamber is approximately the 'black body,' or perfect absorber, of Kirchhoff, so that no correction for reflection is needed. On account of its shape there is great hindrance to the escape of heat by radiation or convection, so that the heat will almost wholly be retained somewhere on the walls. The chamber walls are bathed by a spiral current of water whose difference of temperature before and after passage is determined by a platinum thermometer. To assure that no heat is lost, a known current of electricity can flow through a coil of wire near the rear within the absorbing chamber, and this known heating can be determined as if it came from the sun. The mean of nine comparisons made in this way on Mt. Wilson indicated 100.4 per cent. of the heat introduced found, with a probable error of less than half per cent. Sun heat is more favorably received than coil heat and should be more exactly measured.

The instrument is naturally perfectly continuous in its action, and was mounted equatorially on Mt. Wilson, the galvanometer

measuring the rise of temperature of the water recorded photographically, and the rate of flow of the water, and time of observation were also automatically recorded. This continuous, self-recording and proved instrument is thought to be *a standard pyrheliometer.*

In the general discussion that followed, attention was called to Professor C. A. Young's observations with a faulty Pouillet pyrheliometer in 1872 at Sherman, Wyo., and by Mr. Rosa to the analogy of the new instrument to his great calorimeter used in physiological experiments at Middletown.

Mr. L. J. Briggs then described the 'Centrifugal Methods of Soil Investigation' used at the Department of Agriculture, where some 3,000 soil analyses are made per annum. Since a force 2,000 times that of gravity is available it is easy to produce stratification in a five-gram sample of soil and then to determine the percentages of sand, silt or clay. Further, the water-content of such soils that remains after exposure to a drying force is found as a function of the force and of the percentages of the soil-constituents. Lantern slides illustrated the apparatus and many results. The velocities used run up to 5,000 turns per minute; but a steam turbine has been ordered capable of reaching 30,000 turns.

Charles K. Wead,
Secretary.

THE BIOLOGICAL SOCIETY OF WASHINGTON.

The 407th regular meeting of the Biological Society of Washington was held December 8, 1905, with the president in the chair and thirty-seven persons present.

This meeting was in celebration of the twenty-fifth anniversary of the foundation of the society, at which the following papers were read:

The Potomac-Side Naturalists' Club (here given in full): Professor J. W. Chickering.

In the Floræ Columbianæ Prodromus, compiled by John A. Brereton, M.D., U. S. A., and 'printed in Washington by Jonathan Elliot, and sold at his store on Pennsylvania Avenue' in 1830, we find it stated in the preface that

During the spring of the year 1825, after the dissolution of the late Washington Botanical Society, a few gentlemen of this city, devoted to the science of botany, formed an association, with an earnest determination to explore and to investigate, *de novo*, the indigenous plants growing in the District of Columbia.

This association under the name of 'The Botanic Club,' consisted of Wm. Mechlin, Alex. McWilliams, M.D., Wm. Rich, the compiler, and during the following year, of James W. Robbins, M.D.

One result of this association was the publication of this 'Prodromus' containing 1,922 species. How long 'The Botanic Club' lasted, we know not.

In the 'Records,' which have come into my possession, of the Potomac-Side Naturalists' Club, it is set down that in January 29, 1858,

With the view of forming a scientific club, especially devoted to Natural History, the following gentlemen met at Mr. Simpson's house at seven o'clock in the evening: Mr. T. R. Peale, Dr. E. Freman, Prof. G. C. Schaefer, Dr. C. Girard, Dr. F. V. Hayden, Dr. T. G. Cooper, Mr. Robert Kennicott, Mr. W. Stimpson, with Professor Turner and Mr. W. R. Smith recognized as present in spirit and thus original members.

They adopted the name of Potomac-Side Naturalists' Club, with the provisions that:

The meetings shall be held every Monday evening. The members shall severally entertain the club in rotation in alphabetical order.

The member whose name follows the entertainers, shall at each meeting, deliver a lecture or read a paper upon some subject in natural science chosen by himself.

This meeting adjourned at 2:30 A.M.

In this catalogue are found the names of about fifty members, only a very few of whom still survive.

Two very interesting record books still remain, with accounts of each meeting, members present, papers read, and discussions following.

In the various departments of investigation and discussion, geology most frequently occupied the evening, with zoology, botany and general science, following closely after, in frequency of notice.

The average attendance was ten to fifteen.

At one meeting we find a note.

That every active member of the club shall in each current year or session of the club be required to perform the amount of duty imposed in common upon all, *i. e.*, to read a paper, to receive the club, and preside at a meeting, and that his failure to do so shall be regarded as sufficient reason for erasing his name from the list of members.

Field meetings were held frequently, and botanical novelties exhibited when discovered.

Photography was a frequent subject of discussions.

In 1864, being the seventh year of the existence of the club, the second volume of the records was begun, recording the 128th meeting.

But on March 26, 1866, the record of the 146th meeting closes with 'adjourned *sine die*.'

On May 1, 1873, a meeting was called of those interested in the formation of a Natural History Society for Washington and vicinity, at the house of Professor W. H. Seaman.

Among others present were Professors Baird and Gill, who gave a brief sketch of the two previous societies, and their instrumentality in promoting scientific research and social enjoyment, but adding that they both went to pieces upon the same rock, that of expensive entertainments. Mr. W. R. Smith presented and confirmed the same views.

In the light of these historical reminiscences, it was voted that we resuscitate the old Potomac-Side Naturalists' Club, with meetings at each other's houses, on alternate Monday evenings, but that all refreshments be dispensed with at these meetings. From that time on, meetings were held with tolerable regularity and much of interest, especially in the department of botany.

The members interested in that specialty set themselves to work upon a re-investigation and re-determination of the flora of the district, and a careful comparison of the species found now, with those enumerated in Dr. Brereton's 'Prodromus.'

During the floral season, the meetings were largely devoted to the exhibition and examination of species brought in, or reported as having been found by the botanical members.

Out of this activity grew, in large measure, the 'Guide to the Flora of Washington and Vicinity,' by Professor L. F. Ward, that most valuable aid to the student of botany in this region, published under the direction of the Smithsonian Institution in 1881.

The list of members of this reorganized society numbers fifty-eight, embracing a large number of the well-known scientists of Washington. The average attendance was six to fourteen.

A very interesting feature and help to its existence and activity, was the publication by Mr. Charles R. Dodge, of *Field and Forest, Bulletin of the Potomac-Side Naturalists' Club*, a monthly magazine, containing records of the club meetings, the papers read, and other papers by specialists.

This was continued from 1875 to 1878.

In a circular sent out by the secretary in February, 1876, is found the following statement:

Our club, since its reorganization in 1875, has kept up its meetings, fortnightly, except during the summer vacation.

Since April, 1874, it has found comfortable quarters in the Franklin School building, furnished on condition that the club deposit there a collection of the flora and fauna of the district.

Such a collection is gradually accumulating, and a large amount of material is now in the hands of individual members, awaiting suitable cases for exhibition and preservation.

I fear this hope was never realized.

The club continued its meetings and its activity for about five years, till we find in the record book under date of February 11, 1878, the record of the 218th meeting, but nothing further, and no note of dissolution, so that the organization remained in a state of 'innocuous desuetude,' till the organization of the Biological Society, in 1880, attracted most of the members, and seemed to fill the place formerly occupied by the old Potomac-Side Naturalists' Club.

Its place is now occupied by a number of societies, but its interesting records and its pleasant memories still remain with the few surviving members.

The Early Days of the Biological Society: Theodore Gill.

Then followed numerous notes regarding the work, former and recent, by members of the society, these being given by Mr. Henry Ulke, Dr. L. O. Howard, Dr. E. A. Schwarz, Professor W. P. Hay, Dr. C. E. Waters, Mr. W. H. Osgood.

The Present and Future of the Biological Society: President F. H. Knowlton.

E. L. Morris,
Recording Secretary.

THE GEOLOGICAL SOCIETY OF WASHINGTON.

At the thirteenth annual meeting of the society held on December 13, 1905, the address of the retiring president, Dr. George P. Merrill, entitled 'Development of the Glacial Hypothesis in America,' was presented.

The following officers were elected:

President—George P. Merrill.

Vice-Presidents—Waldemar Lindgren and M. R. Campbell.

Secretaries—George Otis Smith and Arthur C. Spencer.

Treasurer—M. L. Fuller.

At the 173d meeting of the society, January 10, under the head of informal communications, Mr. Fuller described several blowing wells in Georgia. In the case of a certain well investigated where there were in-draft from early morning until about 10 A.M., and after that an out-draft until evening, observation extending over several days showed that the change accompanied a fall in the barometer. Instances of constant in-draft were explained by drawing an analogy to the familiar hydraulic filter pump of the chemical laboratory.

Mr. Gilmore gave an interesting description and exhibited photographs of a skeleton of *Triceratops* from the Laramie formation of Wyoming which he has recently articulated at the National Museum.

Mr. R. S. Bassler exhibited some fossil cystids from the Chazy-Black River strata of the Virginia valley. The speaker stated that when these forms occur in slaty beds they are always greatly deformed, and it is only in the limestone strata that their original globular shape is retained. In specimens where the surface plates are well preserved each plate is reinforced by a column of calcite having approximately the same shape as the plate against which it terminates, and each column is found to be a single crystal. The columns extend toward the center of the cystid, which is frequently hollow, so that the whole affair constitutes a small geode.

The regular program was as follows:

Algonkian Formations of Northwestern Montana: Mr. C. D. Walcott.

This was a repetition of the paper given by Mr. Walcott before the Geological Society of America at Ottawa, which will appear in the forthcoming volume of the *Bulletin* of that Society.

The Franklin Mountains, Texas: Mr. G. B. Richardson.

The Franklin Mountains are the southern extremity of the long, narrow range, known locally by different names, that extends southward from the Rocky Mountains and delimits the Rio Grande Valley on the east as far as El Paso. The mountains are about fifteen miles long, average three miles in width, and rise 3,000 feet above the adjacent low lands. The western face is relatively little dissected and constitutes a dip slope. The eastern side, on the contrary, is much dissected and exposes cross sections of the rocks. From a distance the range appears to be simple, but closer inspection reveals complex conditions.

The oldest rocks in the Franklin Mountains are of pre-Cambrian age and include two distinct formations which aggregate 3,400 feet in thickness. The lower one consists of light and dark quartzite and subordinate slate which have been cut by a few thin diabase dikes. These rocks are succeeded by a bed of rhyolite tuff, ranging from zero to 400 feet in thickness, above which is a mass of porphyritic red rhyolite over 1,000 feet thick. Three hundred feet of indurated, fine-textured sandstone, carrying upper Cambrian fossils, overlies the rhyolite and contains rounded pebbles of the latter in the basal bed. The sandstone is succeeded by a considerable thickness, amounting to at least 5,000 feet, of massive, gray lime-

stone which lithologically is difficult to subdivide, but paleontologically is separable into three main parts which are referred to the Ordovician, Silurian and upper Carboniferous. The Devonian and Mississippian are not represented by sediments. All of these rocks, from the pre-Cambrian to the Carboniferous, are structurally conformable and dip westward at angles varying from 20 to 45 degrees in different parts of the range. A considerable amount of coarse, red granite of post-Paleozoic age occurs in the mountains, chiefly associated with lines of faulting. No sediments of early Mesozoic age are here present, but Cretaceous strata, including the Washita and Benton groups, occur in isolated areas west and south of the range. The adjacent lowlands are underlain by unconsolidated material to a depth of over 2,000 feet.

The rocks are traversed by two prominent sets of joints, striking north-south and east-west, and the distribution of the strata reveals several large faults in both of these directions. The main faulting is parallel with the north-south trend of the range, and as the strata dip invariably toward the west, the internal structure shows a series of tilted blocks. Whether the whole range is a large block limited on the east and west by faults can not be determined since the mountain bases are buried under deep accumulations of débris. The fact of recent movements is proved by the presence of minor faults in a sand bank in the northern part of El Paso. These displacements follow the same trend as the principal faults in the mountains. A detailed description of this region will appear in the forthcoming El Paso folio of the geologic map of the United States.

The Santa Fe Peneplain: Mr. M. R. CAMPBELL.

Mr. Campbell spoke of the existence of a surface of low relief in the vicinity of Santa Fe and its extension northward along the valley of the Rio Grande into San Luis Park, and suggested the probable correlation of this surface of erosion with the peneplain of the great plains region.

ARTHUR C. SPENCER,
Secretary.

THE SOCIETY OF GEOHYDROLOGISTS, WASHINGTON.

THE third regular meeting of the society was held on January 17. The following program was presented:

Method of Sinking Wells in the Sahara: W. T. LEE.

The wells of the Sahara, as described by recent visitors to the region, are still sunk in the same way as they have been for a thousand years. A hole about eighteen inches square is dug to a gypsum layer overlying and confining the water bed at a depth of about 200 feet. The capping is then punctured with a bar by a man at the bottom of the well. In the rush of water which follows the driller does not always escape.

Depth Reached by the Deepest Borings: B. L. JOHNSON.

In this paper only wells or borings having depths over 4,000 feet are considered. Data regarding 48, which are distributed as follows have been obtained: Transvaal, 24; United States, 10; Germany, 6; Queensland, 6, and New South Wales, 1; South Australia, 1. The six deepest are given below in the order of their depth. They are separated from the next deepest by a considerable gap: Paruschowitz, Upper Silesia, Germany, 6,572.6 feet; Schladebach, near Leipzig, Germany, 5,735 feet; Springs, 25 miles east of Johannesburg, Transvaal, 5,582 feet; West Elizabeth, 12 miles southeast of Pittsburg, Pennsylvania, 5,575 feet; Doornkloof, Transvaal, 5,560 feet; Aleppo Township, Greene County, Pennsylvania, 5,322 feet.

Recently Reported Blowing Wells: SAMUEL SANFORD.

In connection with the collection of well records and samples many new instances of blowing wells have come to light. Previous instances have been mainly from Nebraska and adjacent states, but several in the eastern states, including Iowa, Missouri, Arkansas, Louisiana, Wisconsin, Michigan, Indiana, New York, South Carolina and Georgia, are now known. Those of New York, Michigan, Wisconsin and Iowa are in the drift; those of Missouri and Arkansas in cavernous limestone; those of Louisiana, Georgia and South

Carolina in coastal plain deposits; and those of Indiana in sandstone.

Continuously sucking wells are reported in Georgia and Nebraska, but in general the wells are of the breathing type, the movement being outward or inward according to barometric pressure.

Symbols for Representing Underground Water Data: Discussion by members of the society.

To secure uniformity it is considered advisable to adopt some simple set of symbols for use in reports. A circle for wells and a circle with a short irregular line leading off from it (suggesting a stream) for springs were favored. For successful wells the circle is to be made solid (dot), while for unsuccessful wells the circle alone is to be used. Mineral wells are indicated by a dot within the circle. A vertical bar for waters which rise in the wells, a cross (consisting of vertical and horizontal lines) for flows, and a horizontal bar for thermal properties in springs were suggested, each to be superimposed on the fixed symbol for common or mineral wells and springs.

M. L. Fuller,
Secretary.

Discussion and Correspondence.

A new world for the blind.

In *Harper's Magazine* for January, 1860, there is a story by J. D. Whelpley called, 'The Atoms of Chladni.' The tale itself has interest for the curious only, but it pivots upon a contrivance which, as described, is an illustration of the fact that the fancy of man has often anticipated the scientific discoveries of a succeeding time. 'The old discoveries of Chladni' are alluded to as the initial idea whence sprang the mechanism devised by 'Bonsall,' the Merlin and Mephisto of the tale. A broad plate of thin metal is described as suspended from the ceiling by threads of silk. This plate may be 'electrified by vibration.'

> The mirrors of your ceiling are each a vibrating plate. From the upper surface of these rise wire conductors of the electric power generated by the vibration. This is faint and feeble at first, but, by passing through metallic threads coiled a thousand times around small magnets each geometric division of the plate corresponding with a magnet and with a radical sound of the human voice—it has power to connect and disconnect the keys of the batteries. * * * Thus are pinned more or fewer points in this strip of paper, from which, by such wonderful means, has been read off and written every clearly articulated sound uttered in your apartments. There are ninety distinct entries of the record, said Bonsall, closing the book, and of these more than twenty are conversations between the same pair of affectionate lovers. All must have taken place in your room. Your villainous machine records words spoken in your room, above the mirror, as clearly as if they had been uttered below it, in my chamber.

Within the past year or two there have appeared in the magazines and newspapers of the world accounts of a remarkable invention. From one of these—*The Boston Evening Transcript,* October 14, 1905—I quote the following account:

> Conceive a piece of steel wire, generally known as 'piano wire,' stretched between two points, or a steel plate. Take an ordinary electromagnet and connect the coil of it in circuit with the secondary of an induction coil, the primary of which is in circuit with a microphone and battery. On speaking into the microphone induced currents of electricity produce continuous variations in the field strength of the electromagnet, and if we slide the electromagnet along the steel wire or over the plate the magnetic fluctuations of the electromagnet affect the steel wire or plate in the form of variable magnet intensities. There have been impressed on the steel surface undulations of magnetization, a kind of writing that is virtually permanent, and which faithfully records the articulations of the voice. If the coils of the electromagnet are connected with the telephone receiver, and the magnet is made to travel over the steel wire again, the telephone receiver repeats what was spoken into the microphone; or, in other words, acoustic vibrations analogous to the original vibrations of the microphone are produced in the telephone receiver. The records thus made will last for years. The steel wire or plate may be polished without disturbing it. Rust has no effect upon the record. The message remains there until a heavier magnet is drawn over the wire, when it is wiped off or demagnetized.
>
> In one form of the machine a steel plate is

used. In its manner or operation it resembles the ordinary gramophone. The disk is rotated in the same way. The records are not reproduced with the loudness of the gramophone; still, they are distinct and free from the scratching and hissing occasioned by the stylus as it passes over the wax surface. The steel disk which receives the message is about five inches in diameter. As the disk rotates, the magnet and coil, which are held in a carrier, are gradually moved toward the center of the disk by a micrometer screw. The speed of rotation is increased as the magnet approaches the center of the disk, so that the disk rotates beneath the magnet with a constant linear velocity of one half a meter per second. The record is easily erased by passing a bar magnet over the disk. In place of a pair of magnets the two coils, which characterize the earlier machines, a straight magnet is now employed. This magnet is a pointed needle which can be lifted out and renewed, the coil being imbedded in an insulating composition and held in a small ebonite cylinder.

In yet another form a steel piano wire is employed, wound off one wheel to another between two magnet poles by an electric motor contained in the base of the instrument. The speed is about 10.64 feet per second. Enough wire is carried on the reels to make a record three quarters of an hour in length. Should only a part of the record be used at a time, its position can be noted by an indicator finger which rotates at a speed equal to that of the reels. In this machine three pairs of magnets and coils are used, each pair consisting of two magnets and coils similar to the straight magnets previously described. The magnets are placed horizontally, one on either side of the wire. The sounds are recorded by the middle pair of magnets, the pairs on either side serving for demagnetization or erasure. As the wire winds off the magnet carrier travels back and forth, serving both to hold and guide the wire on and off.

As to the genuineness of this discovery, Lord Kelvin, Professor Silvanus Thompson, Mr. Alexander Graham Bell, Mr. Marconi and other scientists have borne abundant testimony. I understand that the invention is soon to be placed before the public, the instruments to be rented to subscribers precisely as the telephone is now supplied.

The sole object of the present writing is to call the attention of philanthropists, educators, social economists, and the medical profession, to an application of the invention which was probably not dreamed of by Mr. Poulson, the Danish engineer who made the discovery. I have spoken into the machine all sorts of messages in every tone and strength of voice, and at once have heard the same speeches returned to my ears with the same qualities of timbre, pitch and intensity, and without any mechanical additions or unpleasant effects.

All of this being true, of what use the now ludicrously cumbrous, expensive, slow and wearying embossed letters and libraries for the blind—the Braille, New York Point, Line Letter, Moon Type, etc.? How vastly may be increased the ease of methods of reading to the sick, the infirm, the aged, of instruction of teachers, of the young and others! A book can be read to the sightless or to the invalid by the machine, while the patient lies in bed. Lectures, concerts, recitations—what one wishes, may be had at will. Skilled readers, or expert elocution teachers could be employed to read into the wires entire libraries, and every taste would thus be easily supplied. Of course the invention could not help those who, in addition to being blind, are deaf.

Letters may be dictated or spoken upon the thin sheets of steel, and these, after being sent by mail to the distant friend, are placed in the machine and the voice is exactly reproduced as regards inflection, emphasis, timbre and pitch. The record does not wear out, and may be used again and again, as often and as long probably as one may wish.

The expense could not possibly be a tithe of that required in the use of the raised or embossed systems of book-making for the blind. The saving of the time of the reader or listener would, of course, be immense. I know nothing about the financial methods or plans of the company which is putting the telegraphone upon the market. I take it the owners of the patent are human and would respond to the double argument that a gift or a sale of the machines at the cost of manufacturing would undoubtedly in the end prove profitable. Even if it were not so philanthropy could be relied upon to furnish the deserving blind of civilized countries with the

machines. There are several hundred thousand blind persons in the civilized world, and benevolence has long vied with charity in lightening the burden of their afflictions, and mitigating the tragedy of their lives. One can not imagine a more speedy and effective means than this of stimulating their *esprit de corps,* arousing mental, educational and social progress, and of placing at their command the learning and science of the world. We are too slowly learning that there is no occupation, whether farming, mechanics, manufacturing, merchandising, or professional life, that may not be worthily, and that has not been successfully, carried on by those without sight. To place within the reach of these this most helpful and noble device would put them at a bound so in touch with one another, and with profitable employment, that other charities in their behalf would lessen in demand and in significance.

GEORGE M. GOULD.

PHILADELPHIA, PA.

COLOR-ASSOCIATIONS WITH NUMERALS, ETC. (FOURTH NOTE.) 1882–1906.

I HAVE given in various places[1] some account of the associations of colors with numerals and letters at epochs in the years 1882, 1883, 1885, 1887, 1889, 1891 and 1895, in the case of my daughter Mildred. The note in *Nature* for July 9, 1891, is the most complete and gives a table which can be consulted by any one interested in this matter. I have recently (January 16, 1906) asked her to give me a list of the colors that she associates with (1) the days of the week; (2) the letters of the alphabet; (3) the numerals 1 ··· 10. Her answers are exactly the same as those given in *Nature* for June, 1891, except for the following very slight differences:

Friday, white with tiny dots; *E,* pink; *K,* grayish brown?; *P,* green, not very clear; *Q,* purplish blue, not very clear; *S,* cream, nearly yellow; *V,* white; *Y,* yellowish cream; 8, white; 9, blue; 10, black and cream (and both colors are seen); 0, cream.

[1] SCIENCE, Vol. VI., O. S., 1885, p. 242; *ibid.,* Vol. I., N. S., 1895, p. 576; *Nature,* Vol. 44, 1891, pp. 223–4.

The series of notes seems to be of value, as it records the results of experiments extending over a period of twenty-four years, made under exceptionally good conditions. To make the record complete it should be added that my daughter married some two years ago and is herself the mother of a daughter. It will be interesting to inquire if this child inherits color associations of the sort from one or both parents. I, myself, see no colors associated with numbers or letters.

EDWARD S. HOLDEN.

U. S. MILITARY ACADEMY,
WEST POINT,
January 18, 1906.

THE YELLOW-FEVER MOSQUITO.

TO THE EDITOR OF SCIENCE: The communication of Professor Vernon L. Kellogg, printed in the number of SCIENCE of January 19, implies that yellow fever and the mosquito *Stegomyia fasciata* do not occur on the Pacific coast of America. Guayaquil, Ecuador, is a notorious hotbed of the disease and there have been numerous outbreaks at points along the Mexican and Central American coast—not to mention Panama. Caldera, the former Pacific coast port of Costa Rica, was abandoned on account of an epidemic, undoubtedly of yellow fever, which swept off a great part of the inhabitants. Upon a recent trip through Mexico and Central America, in the interest of Dr. L. O. Howard's forthcoming work on the Culicidæ, the writer found *Stegomyia fasciata* abundant in the following Pacific coast ports: Acapulco and Salina Cruz in Mexico, Champerico and San José in Guatemala, Corinto in Nicaragua and Puntarenas in Costa Rica. The only port visited which appeared to be free from this mosquito is Acajutla in Salvador, although the species was found at Sonsonate, about twenty-five miles inland. Perhaps on account of its very small size and the scattered disposal of the houses, Acajutla does not offer favorable conditions for this eminently domestic mosquito.

It would seem that at present the greatest danger of the introduction of yellow fever into Hawaii lies in the transportation route across the Isthmus of Tehuantepec, which will soon

be connected by a line of steamers plying between Hawaii and Salina Cruz.

FREDERICK KNAB.

WASHINGTON, D. C.

SPECIAL ARTICLES.

THE PRIMEVAL ATMOSPHERE.

THE geological import of certain chemical work[1] carried out at the University of Heidelberg by Professor Krafft and his students seems to have been overlooked.

Krafft has determined for a number of metals the lowest temperatures at which they evaporate in a nearly perfect vacuum. He estimates the vacuum obtained as having a pressure of less than one millionth of an atmosphere. In order to avoid all action of gravity the evaporation temperatures were determined in a tube (1 to 1.5 cm. diameter) placed horizontally.

He has also determined the boiling points in vacuum of the metals, *i. e.*, the temperature it is necessary to reach to force a steady 'saturated' stream of vapor upwards from the liquid against the force of gravity.

In boiling under ordinary pressure it is necessary to force the stream of vapor upwards against gravity *plus* the atmospheric pressure.

Krafft finds that it requires the same number of degrees rise, within the limit of error of the experiment, to pass from the temperature at which evaporation in a vacuum begins to the temperature at which boiling in a vacuum occurs as to pass from the latter temperature to the temperature at which boiling at atmospheric pressure (760 mm.) occurs.

In other words, that the same rise of temperature is required to overcome the force of gravity at the earth's surface as to overcome the atmospheric pressure and from this the conclusion is drawn that gravity and atmospheric pressure are equivalent.

Krafft's experimental data are given in the following table, also the differences between the temperatures of the beginning of evaporation and boiling in a vacuum (Differences I.) and between boiling in a vacuum and boiling at atmospheric pressure (Differences II.).

Element.	Evaporation Begins in a Vacuum (0 mm.).	Differences I.	Boiling Occurs in a Vacuum (0 mm.).	Differences II.	Boiling at Atmospheric Pressure (760 mm.).
Mercury....	— 40°	195°	155°	202°	357°
Cadmium..	156	294	450	299	749
Zinc	184	366	550	370	920
Potassium.	63	302	365	302	667
Sodium.....	98	320	418	324	742
Bismuth...	270	723	993	707	1700
Silver	680	680	1360	680	2040
		2,880°		2,884°	

It will be noted that, whether a metal of low boiling point or one of high boiling point is taken, the two differences are for any given element very nearly the same. The lack of exact agreement is probably largely due to the experimental difficulty of measuring some of the temperatures.

The writer wishes to direct attention to the bearing of the above on the question of the character of the primeval atmosphere and on the theories of world formation.

The atmosphere is held about the earth by the action of gravity and from the above we are forced to the conclusion that the mass of the atmosphere is as great as gravity is able to control. Perhaps this will be made clearer by the crude comparison of the interaction of the earth and the atmosphere to that of a rotating bar magnet and its iron filings.

The magnet is capable of exerting a certain attractive force. When the filings are present in full amount, *i. e.*, when the magnet can hold no more filings, the attractive force of the magnet for the filings is exactly equal to the attraction of the filings for the magnet. If a less amount of filings were present the attractive force of the magnet would be greater than the attractive force exerted by the filings. If a larger amount of filings were placed in contact with the magnet a certain amount, the 'full amount' mentioned above, would be held and the rest would be thrown off, *i. e.*, the attractive force exerted by the iron filings

[1] *Ber. d. chem. Ges.*, XXXVI. (1903), pp. 1,690 and 4,344; XXXVIII. (1905), pp. 242, 254 and 262. A brief review of the work is given by Professor Renouf, *Am. Chem. Jour.*, XXXIII. (1905), p. 506.

is never greater than that exerted by the magnet.

In the case of the earth and its atmosphere Krafft has given us our first measurement of the attractive force of the earth (gravity) and the attractive force of the atmosphere for the earth (atmospheric pressure) in the same unit of measurement (degrees of heat). His measurements show that the two are equal and we must, therefore, conclude that the present atmosphere of the earth is the largest it is capable of holding. If from any source additions were made to our atmosphere a corresponding amount would be thrown off, *i. e.*, escape from the atmosphere into space. The portion thrown off would probably consist of those molecules having the highest molecular velocities lying in the upper strata of the atmosphere.[2]

The various theories of world formation all give gravity a smaller value in the past than it has at present. There is yet to be found the first evidence tending to show that gravity has ever been greater than at present. If gravity has never been greater than at present then from Krafft's results we must conclude that the atmosphere of the earth can never have been greater than the present atmosphere and the atmospheric pressure never greater than 760 mm. of mercury (14.7 pounds).

We here find ourselves in decided disagreement with the Laplacian hypothesis commonly accepted by geologists and astronomers.

Geikie[3] says: "It is certain that the present gaseous and liquid envelopes of the planet form only a portion of the original mass of gas and water with which the globe was invested. Fully half the outer shell or crust of the earth consists of oxygen, which probably once existed in the primeval atmosphere."

Dana,[4] in discussing the subdivisions of Archæan time, gives perhaps the best statement of the prevalent view:

> The astral æon, as it has been called, or that of the fluid globe having a heavy vaporous envelope containing the future water of the globe or its dissociated elements and other heavy vapors or gases. * * * The lithic era: commencing with earth as a solid globe, or at least solid at the surface; the temperature at the beginning above 2,500° F.; the atmosphere still containing all the water of the globe (amounting to 200 atmospheres, according to Mallet,[5] 1880), all the carbonic acid now in the limestone and that corresponding to the carbon now in the carbonaceous substances and organic substances (probably 50 atmospheres), all the oxygen since shut up in the rocks by oxidation, as well as that of the atmosphere and of organic tissues.

Other calculations of the primeval atmosphere give it the same or even a greater extent, *e. g.*, Prestwich[6] by a calculation later than Mallet's reaches the same value for the water vapor. T. Sterry Hunt[7] finds the carbonic acid alone 200 times the present atmosphere.

A small primeval atmosphere is just as much out of harmony with the idea of the formation of the globe by the contraction of a quasi-gaseous swarm of meteorites, as suggested by Lockyer and by Darwin,[8] and with all other hypotheses requiring for the earth at any time a surface temperature above that of boiling water, as it is with the Laplacian hypothesis. It is, however, in excellent agreement with the planetesimal hypothesis developed by Chamberlin and Moulton,[9] in which

[2] Compare the articles on the conditions of the escape of gases from the atmosphere, by G. Johnstone Stoney, in which he has shown that the molecular velocities of hydrogen and helium are so large that the earth is unable to retain them in its atmosphere. *Trans. Royal Dublin Soc.*, 1892, p. 563; *ibid.*, 1897, p. 305. *Astrophys Jour.*, VIII. (1898), 316; XI. (1900), 251 and 357; XII. (1900), 201.

[3] 'Text-book of Geology,' 4th ed., Vol. I., p. 34.

[4] 'Manual of Geology,' 4th ed., p. 440.

[5] *Quart. Jour. Geol. Soc.*, XXXVI., p. 112.

[6] 'Geology,' Oxford, 1886, Vol. I., p. 417.

[7] Brit. Assoc. Rep., 1878, Trans., Sec. C, p. 544.

[8] Compare Darwin's classic paper, 'On the Mechanical Condition of a Swarm of Meteorites and on the Theories of Cosmogony,' *Trans. Phil. Soc.*, 1888.

[9] Best presented by Dr. Chamberlin in 'Fundamental Problems of Geology,' Year Book No. 3 (1905) of the Carnegie Institution of Washington, pp. 195–258. Compare also Chamberlin, *Jour. Geol.*, V. (1897), p. 653; VIII. (1900), p. 58; IX. (1901), p. 369; Moulton, *Astrophys. Jour.*, XI. (1900), p. 103; Chamberlin and Moulton, SCIENCE, XII. (1900), p. 201.

they show the possibility of a building up of the earth and the present solar system by the gradual accumulation of small bodies. The investigations by Lunn in connection with the study of the planetesimal hypothesis have shown[10] that the probable progressive condensation of the earth under the influence of gravity is sufficient to account for the heat requirements of past geologic ages as well as the present high temperature of the interior of the earth.

It is generally held that the warm and moist climate of the Carboniferous and Tertiary eras was due to an atmosphere much more dense and of much greater extent than the present atmosphere. According to the high authority of Dr. Svante Arrhenius it is not necessary to make such a supposition. An analysis[11] of Langley's experiments gave data showing that the competence of carbon dioxide to retain solar heat is so great that its addition to the extent of only one tenth of one per cent. of the present atmosphere would give us a climate like that of the Tertiary era and that the removal of one fiftieth of one per cent. would bring on glaciation. By later and somewhat more exact experiments of his own Arrhenius[12] obtained results indicating that the percentage changes of carbon dioxide would have to be slightly greater than those calculated from Langley's experiments. We must conclude that our present atmosphere, with but very slight variations, would account for the great changes of climate that have occurred in past geologic ages.

The immense deposits of limestone and coal[13] have been taken to imply a primeval atmosphere containing large amounts of carbon dioxide. Closer examination[14] has shown that it is much more probable that the deposition of limestone and coal has been periodic, as if the atmosphere had been alternately enriched and depleted of carbon dioxide. As a source of carbon dioxide T. Sterry Hunt[15] has suggested that it has been received by the earth, from time to time, through the fall or near contact of meteorites, since small amounts of carbon compounds are found in these bodies. The planetesimal hypothesis considers the earth as largely formed from bodies of the general character of the meteorites that reach the earth's surface. Concerning the competency of these to furnish the gases of the atmosphere no better can be done than to quote Dr. Chamberlin:[16]

> Meteorites carry on the average several times their volume of condensed gas; so do many, probably most, igneous rocks of the earth. * * * Atmospheric material is carried into the earth's body by them to-day in quantities that are large relative to their masses. * * * The gases chiefly occluded in meteorites and the crystalline rocks are hydrogen, carbon dioxide and carbon monoxide in leading amounts, and marsh gas and nitrogen in small amounts. The atmospheric material thus condensed within the growing earth could become part of the atmospheric envelope only by extrusion. * * * It may be assumed that the internal gases were given off progressively and fed the atmosphere.

That the planetesimals were quantitatively sufficient to furnish the gases necessary to supply the earth's water and atmosphere, including the carbon dioxide which has at different stages been taken from the atmosphere, will now be shown. The water and atmosphere[17] at present about the globe are estimated to be about 1/5,000 of the earth's mass.[18] If water be considered as formed by the action of hydrogen on ferric oxide, as there is experimental ground for believing provided the

[10] To be published by the Carnegie Institution of Washington.

[11] *Phil. Mag.*, S. 5, XLI. (1896), p. 237.

[12] 'Kosmische Physik,' II. (1903), p. 503.

[13] The coal deposits while large in themselves are insignificant in comparison with the limestone. The total coal corresponds to less than four tenths of one per cent. of the carbon contained in the limestone. See Dana, 'Manual of Geology,' 4th ed., p. 485.

[14] Compare 'The Influence of Great Epochs of Limestone Formation upon the Constitution of the Atmosphere,' T. C. Chamberlin, *Jour. Geol.*, VI. (1898), p. 609.

[15] *Loc. cit.*

[16] Year Book No. 3, Carnegie Institution of Washington, p. 236.

[17] The mass of the atmosphere is but 1/200 of that of the water and in the present rough calculations may be entirely omitted.

[18] Chamberlin, *Jour. Geol.*, V. (1897), p. 673.

right temperature and pressure are present, then, as hydrogen is but one ninth of water, the amount of hydrogen used to form the water of the earth would be 1/45,000 of the mass of the earth. If we add the amount of carbon dioxide which went to form limestone and carbonaceous substances[19] we will add one fourth the amount of the water, *i. e.*, 1/20,000 of the mass of the earth. The sum of these, 1/14,000 of the mass of the earth, will be the amount of gas which has been driven out from the original material by pressure and heat, and which is now represented by our present water and atmosphere and the carbon dioxide which has been from time to time withdrawn from the latter. If the planetesimals had on an average a density of three, this being the density of the average rock of the earth's surface, and contained on an average two times (Chamberlin above says 'several times') their own volume of gas of the average density of water vapor, then the amount of gaseous substances mentioned above (1/14,000 of the mass of the earth) would be about one seventh of the mass of the gas contained by the planetesimals from which the earth was formed. This may be shown as follows: An average gram of material contained in a planetesimal would contain two thirds of a cubic centimeter of gas (density taken as 18/32 of that of oxygen), weighing .00051 gram at 15°. If it gave off only the amount mentioned above, 1/14,000 of its mass, it would give .00007 gram, which is about one seventh of .00051 gram, the amount it is capable of giving off.

Ralph H. McKee.

Lake Forest University,
January 6, 1906.

[19] Dana, *loc. cit.*

CURRENT NOTES ON METEOROLOGY.

TEMPERATURES IN CYCLONES AND ANTICYCLONES.

In the Archives of the Imperial Academy of Sciences of St. Petersburg for June, 1905, of which a reprint has lately been received, Mr. A. Lawrence Rotch reported upon the results obtained by means of kites at Blue Hill Observatory regarding the temperature of the free air in cyclones and anticyclones. Thirty-four ascents showed a vertical decrease of temperature in cyclones and anticyclones at a much lower rate than the adiabatic rate of cooling in ascending air, and also showed almost the same rate of decrease in low and high pressure areas up to 3,000 meters. In view of this latter fact, as Teisserenc de Bort pointed out, the temperature of these two columns of air, up to height of say 4,000 meters, depends to a large extent on the season and upon geographical conditions, as well as upon the relative position of the pressure system. The thirty-four cases were distributed equally among cyclones and anticyclones, and among different seasons. Yet the mean sea-level temperature at a mean pressure of 29.646 ins. was 48.4°, and at 30.157 ins. the temperature was 48°. The following table summarizes the results.

	Meters Above Sea Level.							Mean.
	0	500	1,000	1,500	2,000	2,500	3,000	0 — 3,000
Mean Pressure 29.646″, Temp.	48.4°	44.2°	39.2°	34.3°	31.5°	28.0°	22.6°	35.4°
Mean Pressure 30.157″, Temp.	48°	43.7°	38.7°	35.2°	31.3°	27.1°	21.7°	35.1°

A better method, first used by Mr. Clayton in connection with kite ascents in 1899 and 1900, is to determine the temperatures at the same heights for several days in succession while changes of pressure and temperature are taking place at the earth's surface. By this method it was found that the maximum temperature at all heights up to about 4,000 meters nearly coincided with the minimum pressure at sea level, but was somewhat ahead of it, and that the minimum temperature at all heights coincided with a sea-level pressure above normal, but preceded the latter at a considerable distance.

A LABORATORY MANUAL.

A very convenient form of laboratory notebook is found in Professor Frank W. Darling's 'A Laboratory Manual in Physical Geography' (Atkinson, Mentzer & Grover, Chicago and Boston, 1905). All teachers who

have had the labor of handling large numbers of papers and maps in laboratory exercises in physiography and in meteorology will appreciate this publication. In flexible covers, we have, on separate sheets held together by paper fasteners, fifty-five exercises, in very direct and precise form, designed to call the attention of the student to the essential points in each subject discussed. The exercises can be put in any order that is desired, and any teacher can add, subtract or multiply as he sees fit, or as his opportunity permits. At the end of the note-book there are a number of extra pages of blank paper, and also sheets of section paper, and outline maps of various kinds. Several copies of each of these maps are included, for use in different exercises.

About one half of the exercises are meteorological in their character, and are on the whole satisfactory and well worded. It is easy to say that they might be improved, because they probably do not exactly fit the demands of any large number of teachers. But with all the limitations which must be expected in any scheme of laboratory work designed by *some* persons for *other* persons, we may, nevertheless, commend Professor Darling's 'Manual' as a very useful, compact and effective laboratory guide, which can not fail to improve and systematize laboratory teaching in physiography and meteorology. We suggest that the blank tables for entering the meteorological records are too rigid, and do not call for that variation from week to week which is an essential in keeping up interest in the subject. And we fail to see how the outline weather maps can be copyrighted, for they seem to us nothing more than a reproduction of the regular Weather Bureau station map.

NOTES.

OBSERVATIONS of temperature during the recent solar eclipse made on board the P. and O. steamship *Arcadia*, off the coast of Spain, showed a fall from 82.4° to 72.5°.

Dr. J. M. Pernter, whose book, 'Meteorologische Optik,' covers a field in meteorology which had not previously been occupied, has recently published two additional studies along the same line. These are entitled: "Erklärung des fälschlich 'weisser Regenbogen' benannten Bouguer 'schen Halos," and 'Zur Theorie des von einer kreisförmigen Lichtquelle erzeugten Regenbogens.' Both appear in the *Sitzungsberichte* of the Vienna Academy of Sciences, June and July, 1905.

Apropos of the recent note in SCIENCE concerning the results obtained by Mr. Clayton during the past summer in sounding the free air over the tropical Atlantic, it may be worth while to call attention to two papers by Hergesell on this same subject in the *Beiträge zur Physik der freien Atmosphäre*, Vol. I., No. 4, 1905. In these papers are discussed the results obtained by Hergesell while on the yacht of the Prince of Monaco in the summers of 1904 and 1905.

The U. S. Weather Bureau eclipse party at Daroca, Spain, observed a fall of 8° in temperature during the eclipse. There was no notable change in the wind.

THE November number of *Education* contains an article by Dr. Frank Waldo, on 'The Study of Meteorology,' which deals chiefly with meteorological and climatological instruction given at Harvard.

'HÖHENKLIMA und Bergwanderungen in ihrer Wirkung auf den Menschen' is the title of an elaborate work just issued in Germany. The authors are teachers at the University of Berlin (Loewy and Müller), and at the Landwirthschaftliche Hochschule in Berlin (Zuntz and Caspari). The book numbers nearly 500 pages, and presents the results of experimental studies on high mountains and in the laboratory. It contains many illustrations.

THE self-recording rain-gauge designed by S. P. Fergusson, of Blue Hill Observatory, is now constructed and for sale by the International Instrument Company, of Cambridge, Mass.

A SMALL-SIZE, relatively inexpensive, so-called piesmic barometer, designed by A. S. Davis, is for sale by F. Darton & Co., St. John Street, London, E. C., for £1 to £1 15 s. This barometer has a tube seven inches long,

whose mouth can be closed by a screw when the instrument is being carried.

R. DeC. Ward.

A COLORADO SCHOOL OF FORESTRY.

Through the generosity of Gen. William J. Palmer and Dr. Wm. A. Bell, of Colorado Springs, Colorado College is to have a School of Forestry. These two gentlemen, who take great interest in forestry, have given to the college the beautiful tract of land known as Manitou Park, with its 15,000 acres of forest, haylands and lakes. A conservative estimate places the value of this gift at $150,000.

The park is twenty-five miles northwest of Colorado Springs on a plateau, 7,550 feet above sea level. The climate and soil are typical of the mountains. Many years ago the whole tract was deforested, but at present there is a fine new growth of conifers. In every respect it offers excellent opportunity for field work and the practical study of silviculture and forest botany. The theoretical and lecture courses in this new department will be given at Colorado College. The new science building completed in 1903, with its modern and well-equipped laboratories makes possible the study and research which this new movement entails.

No better location could be found for such a school than Colorado College. Situated at the foot of Pikes Peak, where the Rocky Mountains touch the arid plains, it affords fine opportunities for the study of irrigation, as well as of forestry problems. The whole irrigation problem must, in the last analysis, be determined by the forest coverings of the mountains, for the mountains are the natural sources of water supply for the plains. Where they are denuded of forest, they can not hold water; rain and the snow water rush off in torrents that can not be utilized. The forest covering equalizes the water supply of the plains by restraining the water, allowing it to flow down slowly and gradually so that it can be properly distributed. The Pikes Peak forest reserve is also near; here the central government has established three nurseries to provide trees for the reforesting of denuded slopes. On Pikes Peak and other near-by mountains are found a great variety of climates, from the arctic-alpine down to the more temperate.

The establishment of this School of Forestry means much for the Rocky Mountain region. It is said that the first settlers in the state of Colorado found 36,000 square miles of forest area covered with various kinds of valuable pines and spruces. Since that time 30,000 square miles of the virgin forests of the state have been destroyed. Evidence introduced in the Kansas-Colorado water suit showed that the cutting away of the forests on the mountain sides has greatly decreased the amount of water available for irrigation. The influence of the school will do much toward checking this waste and establishing better economic conditions.

Professor Gifford Pinchot, forester, U. S. Department of Agriculture, has agreed to nominate a man to act as head of this new department of Colorado College, which will be opened next September.

THE GEOLOGICAL SURVEY OF ILLINOIS.

The State Geological Commission, at its meeting at Springfield last week, completed the corps and arranged for the season's work. The following appointments were made to the regular force, and in addition the director was authorized to make such temporary appointments as might be necessary, subject to confirmation at a succeeding meeting of the commission.

Professor C. W. Rolfe, of the State University, consulting geologist in clay work.

Professor R. D. Salisbury, of the University of Chicago, consulting geologist, in charge of educational work.

Dr. U. S. Grant, of Northwestern University, consulting geologist in lead and zinc work.

Professor S. W. Parr, of the State University, consulting chemist in coal work.

Dr. Edward Bartow, director of the State Water Survey, consulting chemist in water work.

Mr. F. B. Van Horn, recently of the Missouri Geological Survey, assistant geologist.

Mr. F. F. Grout, recently of the West Virginia Geological Survey, assistant chemist.

Mr. H. B. Fox, of the State University, assistant geologist.

J. A. Udden, professor in Augustana College, geologist.

W. W. Atwood, of the University of Chicago, geologist.

Dr. Stuart Weller, of the University of Chicago, geologist.

Mr. Ross C. Purdy, of the State School of Ceramics, ceramist.

Not all of the men appointed will be able to devote their full time to the survey work, but assurances have been received that all will give some time to it. Professor Rolfe and Mr. Purdy, assisted by Mr. Fox, will devote particular attention to the clay resources of the state beginning their work probably with a study of paving brick and the clays used in its manufacture.

Professor Parr, Mr. Grout, Mr. Van Horn and the director of survey, Mr. Bain, will devote their time largely to a study of the coal fields. It is proposed to take samples of the various seams and to study their qualities as well as their distribution in the field. In the latter work Dr. Weller and Mr. Atwood will assist.

Professor Udden will devote his time to a study of the underground waters of the state with a view to the determination of the limits of the various artesian basins and the depth to which it is necessary to go to obtain good water for municipal and other purposes. In this work he will be assisted by Dr. Bartow and the State Water Survey, which will make the necessary analyses and laboratory tests.

Dr. Grant, with such assistance as may be necessary, will take up the study of the lead and zinc fields found near Galena continuing the work done by the state of Wisconsin.

Professor Salisbury, assisted by various others yet to be appointed, will prepare a series of bulletins for use in the schools, descriptive of the geography and the geology of important type localities within the state. So far arrangements have been made for such bulletins covering the lake shore from Evanston north, the Illinois Valley near Peoria, and the Mississippi Valley between Savanna and Rock Island, and at East St. Louis. The first of these bulletins is now being prepared by Mr. Goldthwaite, of Northwestern University, and Mr. Atwood, of Chicago.

THE MEMORIAL OF MAJOR WALTER REED, U. S. A.

THE executive committee of the Walter Reed Memorial Association, consisting of Daniel C. Gilman, George M. Sternberg, Chas. J. Bell, A. F. A. King, J. R. Kean, W. D. McCaw and Calvin DeWitt, has issued, under date of February 1, the following letter:

You are doubtless aware that to Major Walter Reed, surgeon U. S. Army, is due, in a very large degree, the demonstration that yellow fever is propagated by a mosquito. By this demonstration the spread of the pestilence has been averted, and, when proper precautions are taken, the danger is almost annihilated. The immense benefits which have come to humanity from this discovery can hardly be estimated.

Under these circumstances, a general desire has been shown to honor this great benefactor, and likewise give to his widow some recognition of his service to mankind. An incorporation has been formed in Washington which is endeavoring to raise a fund of $25,000, the income to be paid to his widow and the principal to be reserved for a permanent memorial in the city of Washington. The amount now subscribed is somewhat over $16,000; by far the largest number of contributors are of the medical profession. There is one subscription of $2,000, two of $1,000, two of $250, several of $100, and many of less amount. The association in charge of this movement considers that the time has now come to appeal to a wider circle than has yet been reached and to ask their subscriptions.

Your support is respectfully solicited, and any amount that you may be disposed to contribute may be sent to the American Security and Trust Company of Washington, D. C., the president of which, Mr. Charles J. Bell, is treasurer of the fund. To complete the fund and cover incidental expenses, including a marble bust of Major Reed, $10,000 is needed. The desire of the committee is to close the subscription before the end of this month. Communications should be addressed to the secretary at No. 1707 21st Street, N. W., Washington, D. C.

SCIENTIFIC NOTES AND NEWS.

AT a meeting of the Royal Astronomical Society at Burlington House, London, on February 9, Ambassador Reid received the gold medal for 1905 conferred by the society

on Professor William Wallace Campbell, of the Lick Observatory.

It is announced that Major-General A. W. Greely, who was advanced to that rank by the promotion of General Bates to be lieutenant-general and chief of staff, will be sent to command the southwestern division, with headquarters at Oklahoma City.

President W. G. Tight, of the New Mexico University, Albuquerque, has been seriously injured by an explosion of gasolene while experimenting in his laboratory.

Professor J. J. Thomson, of Cambridge; Mr. Oliver Heaviside, of London; M. Henri Becquerel, of Paris, and Professor P. Zeeman, of Amsterdam, were made honorary doctors of the University of Göttingen, on the occasion of the dedication of the new physical laboratory.

Dr. Paul Drude, professor of physics in the University of Berlin, has been elected a member of the Berlin Academy of Sciences.

Professor Karl von den Steinen, of Berlin, has been made an honorary member of the Anthropological Institute of Great Britain and Ireland.

Dr. Konrad Pressel, the engineer-in-chief of the Simplon tunnel, has been made an honorary professor in the Technological Institute of Munich.

Professor Josiah Royce, of Harvard University, has given during the last two weeks, at the Johns Hopkins University, a series of lectures upon 'Aspects of Post-Kantian Idealism.'

Professor T. H. Morgan, of Columbia University, will deliver the ninth of the Harvey Society lectures, on February 17, at 8:30 o'clock in the hall of the New York Academy of Medicine. The subject will be 'The Extent and Limitations of the Power to Regenerate in Man and Other Vertebrates.'

Mr. Benjamin Kidd delivered at the Royal Institution, on February 1 and 8, lectures on 'The Significance for the Future in the Theory of Evolution.'

The Court of St. Andrews University has appointed Mr. Andrew Carnegie, rector of the university, to attend, as a representative of the university, the celebration to be held under the auspices of the American Philosophical Society, in Philadelphia, in April, of the two hundredth anniversary of the birth of Benjamin Franklin, who in 1759 received from St. Andrews the honorary degree of LL.D.

The triennial Rinecker prize given by the medical faculty of Würzburg, Germany, was awarded this year to Dr. E. Overton, assistant at the Würzburg Institute of Physiology. His researches have been on the osmotic properties of cells, the mechanism of narcosis and the importance of the mineral elements for the functions of the cells.

Dr. Otto Nordenskjöld and Capt. Mikkelsen were the guests of honor at a dinner given by the Arctic and Explorer's Clubs in New York City, on February 7. It was announced that Dr. Nordenskjöld would sail on the 8th inst. for his home in Sweden, to arrange for another voyage in search of the south pole. Capt. Mikkelsen is getting ready an expedition to the Beaufort Sea, an unexplored Arctic area west of the Parry archipelago.

The *Electrical World* says: "The city of Brantford, Canada, has, it is said, determined to set a good example to those cities that wait to honor a distinguished son until he is dead. The town's recognition of Alexander Graham Bell's services to humanity in inventing the telephone will take the shape of a memorial to be erected some time this year. To arrange details a committee has been formed. It has been suggested that the old Bell property at Brantford should be bought and maintained as a park. Dr. Bell's father went from Edinburgh to Brantford in 1870 and some of the very earliest experiments of a telephonic nature by Bell are said to have been made from his father's house to that of the Rev. T. Henderson in June, 1875."

Dr. William Osler, who is at present in Canada, expects to return to England at the end of the month.

Professor Angelo Heilprin, who has now in preparation his final report upon the phenomena of the Pelée eruptions, sailed from

New York on the tenth of this month on his fourth journey to Martinique.

DR. GEORGE BYRON GORDON, of Philadelphia, and Dr. Charles Peabody, of Cambridge, have been appointed delegates from the American Anthropological Association to the International Congress of Anthropology and Prehistoric Archeology to be held at Mocano, April 16, 1906. Mr. David I. Bushnell, Jr., who is in Europe making a special study of the American collections in the museums of Italy, France and England, has been appointed a delegate from the Peabody Museum of Harvard University to the congress.

ON February 6 Dr. Wm. E. Ritter, professor of zoology in the University of California and scientific director of the Marine Biological Station of San Diego, sailed from San Francisco on a journey around the world. He will spend a month in the Hawaiian Islands, two or three months in Japan, and will attend the Congress of Oceanography and Fisheries at Marseilles, France, as a representative of the oceanographic and marine biological investigations being carried on by the University of California through the San Diego Marine Biological Station. During Dr. Ritter's absence from America, Professor C. A. Kofoid will be acting-director of the San Diego work. Inquiries concerning the laboratory may be addressed to him at Berkeley, Cal., until May 15. After this date, during the summer, his address will be La Jolla, California.

THE Philosophical Institute of Canterbury, Christchurch, New Zealand, has opened a fund with the object of establishing a memorial to the late Captain F. W. Hutton, F.R.S., president of the New Zealand Institute. It is proposed to devote the fund to the encouragement of original research in natural science in New Zealand by making grants for original research, and by the award of a bronze medal, to be called the 'Hutton medal.'

EMPEROR WILLIAM, of Germany, celebrated his forty-seventh birthday on January 27. In honor of the birthday a Leibnitz medal has been established to be awarded annually by the Berlin Academy of Sciences for notable scientific achievements.

DR. JOHN SLADE ELY, professor of the theory and practise of medicine in the Yale Medical School since 1897, died on February 7, as a result of a fracture of the skull due to a fall from his horse. Dr. Ely was born in New York City, in 1860. He had been assistant in pathology in the College of Physicians and Surgeons, Columbia University, and professor of pathology in the Woman's Medical College.

PROFESSOR KARL VON KORISTKA, formerly professor of geodesy in the Technical Institute of Prague, has died at the age of eighty years.

MISS ELLEN B. SCRIPPS, of La Jolla, California, has addressed a letter to President Benj. Ide Wheeler and Professor Wm. E. Ritter, of the University of California, signifying her intention of giving $50,000 to the board of regents of the university for the Marine Biological Station at La Jolla. This gift is in recognition of the need of buildings, equipment and endowment for the station, to the support of which Miss Scripps and her brother, Mr. E. W. Scripps, of Miramar, California, have previously contributed considerable sums. Miss Scripps expresses the wish that a laboratory building be erected somewhere in the vicinity of San Diego to be known as the George W. Scripps Laboratory.

IT is hoped that the Cancer Institute, in the foundation of which Professor Czerny has taken a leading part, will be opened at Heidelberg on the occasion of the Cancer Congress which is to be held there in the middle of September next. Already a sum of $175,000 has been contributed towards the cost, and the government of the Grand Duchy of Baden and the University of Heidelberg have between them undertaken to maintain the institute for at least fifty years.

THE Hamburg Institute of Marine Pathology and Tropical Diseases is about to be enlarged. Both the teaching staff and the accommodation for workers will be increased; the course of study for medical officers of the army, navy and colonies will be extended, and the library enlarged. It is proposed to offer

the post of scientific assistant in zoology to Dr. Schaudinn.

The Edison medal committee of the American Institute of Electrical Engineers, Mr. John W. Howell, chairman, has issued a circular to the educational institutions of the United States, calling their attention to the fact that funds are available for the award of the medal this year and pointing out the conditions under which students can enter in competition for it.

The commission for the methods of examining and methylating alcohol, appointed by the French government, has decided to offer the following prizes for open competition, irrespective of the nationality of the competitors: (1) a prize of 20,000 francs for a method of methylating alcohol, which shall be preferable to that now in vogue in France, and which at the same time shall prevent any defrauding of the revenue; and (2) a prize of 50,000 francs for a system which shall permit of the use of alcohol for illuminating purposes under the same conditions as those for the use of petroleum.

UNIVERSITY AND EDUCATIONAL NEWS.

At the last meeting of the trustees of Columbia University gifts amounting to $318,000 were announced, including $150,000 from Mrs. Marie H. Williamson to establish a fund in memory of Edward R. Carpentier, the income of which is to be used for a professorship or lectureship on the origins and growth of civilization, and $100,000 from Mr. George Blumenthal for the endowment of a chair of politics.

The fund collected by the alumni of the Massachusetts Institute of Technology for current expenses within the next five years amounts to $211,000. There are eleven hundred subscribers.

Colonel I. H. Wing, of Batfield, Wis., an alumnus of Bowdoin College, has given the college $50,000 to endow the chair of mathematics.

Mr. Andrew Carnegie and Mr. Bartlett Doe have each given $50,000 to Bates College. Mr. Carnegie has also offered to give Swarthmore College $50,000 for a library building, on condition that an equal sum be raised from other sources.

By the will of the late Dr. S. Stanhope Orris, formerly professor of Greek at Princeton University, the institution receives a bequest of $25,000 to found ten new scholarships for undergraduates.

By the will of Mrs. Mary C. Daniels, of Litchfield, Conn., the sum of $6,000 is bequeathed to Trinity College, Hartford, for a scholarship.

Syracuse University will erect at once a three-story chemical laboratory, 150×100 feet, and expects to have it ready for occupancy by September, 1907.

A bill has been prepared for presentation to the New York legislature establishing a university in Brooklyn.

McGill University is to establish an affiliated college in Vancouver, British Columbia, to be known as the University College of British Columbia.

The mechanical engineering building of the University of Pennsylvania was completely destroyed by a fire which broke out the night of February 6, the loss sustained being nearly $100,000. Most of this amount was covered by insurance. As the new engineering building is almost completed, the faculty has decided to transfer the department to it.

Yuan. Shi Kai, viceroy of Chi Li province, has discharged Professor C. D. Tenney, the foreign director of education, who organized the new school system in this province.

The trustees of Rutgers College have elected Dr. W. H. D. Demarest president of the college, to succeed Dr. Austin Scott. Dr. Demarest has been acting president for several months.

Upon the nomination of the Prussian Ministry of Education, the trustees of Columbia University have appointed Dr. Hermann Schumacher, professor of political economy in the University of Bonn, to be honorary professor in Columbia University for the year 1906–7.